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ABSTRACT

The development of a methodological framework for planning, programming, and budgeting which is specific to graduate training and research activities at the Chalmers University of Technology in Sweden is described. This pilot project is regarded as a step towards developing and implementing a generalized approach to an output-oriented finance system for graduate training and research at the university level. In the first three chapters of this report, the present status of the PPBS is described. They are devoted to an overview of program budgeting, an analysis of the national and local organization for higher education and research, and an economic review of the program activities. Basic concepts of program budget theory, such as productivity and effectiveness, are defined. The survey for the pilot study is divided into time utilization, cost accounting, space and equipment, and output measures. The proposed PPB-model to be applied to higher education and research is given along with the consequences of its introduction in the university system. Extensive appendices are included. (LBH)

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PROGRAMME ON INSTITUTIONAL MANAGEMENT IN HIGHER EDUCATION

CHALMERS UNIVERSITY OF TECHNOLOGY

# *PROGRAMME BUDGETS FOR GRADUATE TRAINING*

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OECD ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

*Centre for Educational Research and Innovation (CERI)*

PROGRAMME ON INSTITUTIONAL MANAGEMENT
IN HIGHER EDUCATION

CHALMERS UNIVERSITY OF TECHNOLOGY

# PROGRAMME BUDGETS FOR GRADUATE TRAINING

*Project Leader : Claes G. Appelquist*

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**1974**

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⁂

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# PREFACE

In CERI's Programme on Institutional Management in Higher Education eight universities were brought together to set up teams within their institutions to work on their respective pre-selected problem areas (1). These teams have worked over varying lengths of time, none of which exceeded two years. The results of their work, together with the results of the in-house research of the Secretariat were presented before a wide audience of university executives and managers and government representatives from the OECD Member countries at an Evaluation Conference held in Paris on 25 November 1971.

The Programme's work has now produced analyses of the major problem areas of university management and the general directions in which solutions to these problems must be sought. By concentrating the effort in selected university environments the approaches developed may not have the attraction of generality, but this has been more than offset by the demonstration of concrete ways of tackling the specific problems of university management.

This effort represents significant contributions in at least four areas :

First, conscious of the fact that universities have become major consumers of financial resources, it has been possible to indicate methods for evaluating the requirements of resources and their costs not only for the university as a whole but especially for its different components. This has involved the use of the budget as a planning tool by linking the expenditures, as far as possible, to the objectives of the programmes for which these expenditures have been incurred.

Second, it has been possible to demonstrate the costs and the consequences of different decisions concerning selected university matters both for current operations and for expansion, in order that policy-makers may

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1) These universities are the Free University of Berlin, University of Bradford, University of Copenhagen, Chalmers University of Technology, Gothenburg, University of Lancaster, University of Nijmegen, University of Novi Sad, Université de Paris X-Nanterre. The University of Copenhagen project was, however, carried out by a team from the Technical University of Denmark.

choose desired courses of action. Such an approach offers an opportunity for effectively reducing the arbitrariness of decisions concerning the allocation of resources, and thereby improving the general efficiency of operations.

Third, from early in the development of the programme it was found that the basic information requirement for university-wide management was either lacking or was too dispersed among various bodies for its effective utilisation by decision-makers. It was possible, in the programme, to carry out pilot exercises not only to determine information availability and requirements, but also to propose the creation of an information base within the university geared to the needs of the decision-makers.

Fourth, computer-based mathematical techniques and models have been constructed and tested to demonstrate their potential usefulness in providing a range of results quickly and efficiently, not only for the specific problems of the university for which they were constructed, but also for similar problems in a large number of different universities.

The studies carried out so far have clearly demonstrated that despite great diversity of environment in which the university functions and the variety in the pattern of their organisation, they nevertheless share common problems which can be tackled through inter-institutional/international effort.

The PPBS project at Chalmers University of Technology (CTH) was launched in summer 1969 and was informally associated with the programme on Institutional Management in Higher Education of CERI. Representatives from the Office of the Chancellor of Swedish Universities and CTH participated in the meetings of the project leaders and other centre-based activities arranged by CERI. During this time a valuable exchange of information was carried out between the project and the CERI staff.

This report is the product of research carried out in the Department of Planning at Chalmers University of Technology, sponsored jointly by the Organisation for Economic Co-operation and Development's Centre for Educational Research and Innovation and the Swedish Ministry of Education and Cultural Affairs. The project was carried out over a six-month period during 1971 under the leadership of Mr. Claes G. Appelquist. It was a pilot project concerned with the development of a methodological framework for planning, programming and budgeting which is specific to graduate training and research activities at the CTH in Sweden. It is regarded as a step towards developing and implementing a generalised approach to an output-oriented finance system for graduate training and research at the university level, with particular emphasis on technical universities in Sweden. As a result of its experience in applying PPBS techniques to undergraduate education the project represented a natural continuation of previous work undertaken by CTH in programme budgeting.

Dr. Nils Gralén, Rector of the Chalmers University of Technology, played an important role in the project both by the interest he showed in the plans and results, and by providing valuable advice during the course of the project. Dr. Gralén also participated in the Steering Committee of Rectors/Vice-Chancellors which guided the CERI Secretariat in finalising the first phase of its programme of work on Institutional Management in Higher Education.

Mr. Ragnar Thun, Chief Administrative Officer of CTH, should also be acknowledged for his support and assistance during the project.

We wish to thank Messrs. Johnny Andersson and Bengt Lindstedt of the Office of the Chancellor of the Swedish Universities for contributing an introductory chapter to this report which was prepared especially for inclusion and provides the reader with a more recent assessment of the experiences gleaned from experimental programme budgeting in Sweden.

Dr. Abdul G. Khan was the staff member responsible for the CERI Programme on Institutional Management in Higher Education, and as such has played an overall co-ordinating role for the whole Programme. He was assisted by Dr. Paul M. LeVasseur.

## Introductory Chapter

# EXPERIMENTAL PROGRAMME BUDGETING IN SWEDEN : AN ASSESSMENT

by Johnny Andersson and Bengt Lindstedt
of the Office of the Chancellor of Swedish Universities

## INTRODUCTION

During the spring of 1971 a project was conducted at the Chalmers Institute of Technology within the framework of CERI's development programme of Institutional Management in Higher Education. The object of the project was to examine the possibilities for and forms of a financing system for the education of technical researchers and for research - a financing system that would be arranged according to purpose and be geared to results. The aim of the project was considered particularly important in view of the experimental programme budgeting initiated at the Chalmers Institute of Technology (CTH).

The project, which comprised partly a tabulation of information on research training and research at CTH, and partly a survey of costs, activities and achievement at three CTH institutions, was divided into three phases :

1. A tabulation and definition of research training and research at CTH;
2. Analysis of resources invested and measurement of results, and a presentation of the organization of research work and research training ;
3. Proposals for a general programme budget system for technical research and training of researchers.

The project resulted in a proposal for an outline for a programme budget system for technical research training and research at the Chalmers Institute of Technology that would also be applicable to other technical colleges. The proposal offers precise details on the sub-systems that a developed programme budget system comprises, that is :

- a programme and target system;
- a financing system;
- an organization system;
- a planning system and
- an information system.

The proposals and theories presented in the following report have been of great importance and have promoted several ideas in the formulation of experimental programme budgeting in higher education and research.

In view of the time that has passed since the completion of the project we will give here a general description of the formulation of and the experiences gleaned from experimental programme budgeting in Sweden, and in particular with regard to higher education and research. We will also deal very briefly with the plans for the formulation of the system of grants for higher education and research that the 1968 Educational Commission put forward in its main report presented recently.

## 1. EXPERIMENTAL PROGRAMME BUDGETING IN SWEDEN

Compared to the situation in other countries the central administrative boards in Sweden are in a particular position. The administrative boards are subordinated to the Crown but, as far as organization is concerned, independent of the ministries. Their primary task is to implement, within an administrative area determined by the Crown, decisions made by the Swedish parliament and the government. The experimental programme budgeting that was initiated in 1968 involved the central administrative boards.

Experimental programme budgeting is a step towards the improvement of the economic-administrative system at government agency level. The development of the economic-administrative system also includes the introduction of an accounting system common to the entire public administration, comprising partly cost accounting, which is a prerequisite for programme budgeting, and partly a re-organization of auditing. Parallel with the development work on the budget system that is being conducted with regard to the government agencies, a work group appointed by the Crown in 1969 is examining, inter alia, the possibilities of grouping government work at governmental and parliamentary level according to purpose, and of formulating the budget system on this basis.

## Experimental programme budgeting at government agency level

Experimental programme budgeting in 1973 involves about twenty-five government agencies. Of these 16 were given their grant in 1973 in programme terms. In all, the experimental work covers administrative boards within all the ministries fields of activity.

The motive for experimental budgeting was to test, on the basis of general discussions on new forms for the grant system and the increasing government expenditure, forms for a planning and control system that would be better than the present grant system,would further effectiveness in government administration, limit costs of current activities and facilitate choice between various alternative courses of action of great importance. In the Government Budget Proposals for 1969:app. 2, the head of the Ministry of Finance stated with reference to proposals for programme budgeting, that

"the rate of the present expansion of society's efforts is greatly dependent on cost development in activities already in progress. An important prerequisite for an improved division of resources and a more effective utilization of resources is that the government has a fund of information and a planning technique that enables it to apportion resources in the best way between various activities and enables the government agencies to utilize such resources in the best way.

Programme budgeting means that the government allocates grants geared to specific purposes for activities with defined aims. Budgeting will be effected on the basis that the government agencies will obtain the results for which the costs were laid down. Government agencies would be accorded greater freedom to select, within the outline drawn up, the production factors giving the best results. The outcome of these activities and of the budget should be analyzed continuously during the course of the fiscal year and in one context after the termination of the fiscal year. In this analysis a check should be made to ensure that business is being so conducted that the best possible results are attained for a given investment.

The term programme budgeting also means that the government must continuously examine alternative targets for the various sections of government. In this way not only marginal changes in expenditure but the entire work should be made the object of regular government examination.

The budget system is to stimulate government agencies to develop and report alternative means of achieving the aims set. On this basis I see programme budgeting as an instrument which can considerably facilitate the government's political and economic decisions. For government agencies it will be a means of a more rational execution of the tasks given them by the government."

The setting up of a programme budget system by an administrative board should, according to the report forming the basis of programme budgeting work at government agency level (SOU 1967:11), centre around programme, results, costs, productivity, and effectiveness, where :

- programme is defined as being a plan of results and costs for activity aimed at achieving a given target;
- results refer to the goods or services which constitute the direct concrete result of the work done by a government agency;
- costs are defined as those sacrifices of production factors - normally connected with the activity, and expressed in terms of money - as can, at least approximately, be pre-estimated;
- productivity is defined as the relation between results and costs, and
- effectiveness is described as the relation between the result (target attainment) and costs.

A government agency can in principle have several programmes. The programme grouping determined at the government agency, however, is to form the basis of planning, budgeting, accounting and supervision. Special emphasis should, according to the Commission, be placed on the planning of activity, and this should refer to both long-term and short-term aspects.

The National Swedish Accounting and Audit Bureau, which, inter alia is to promote effective planning, budgeting and accounting in government services, has been appointed by the Crown to evaluate, in co-operation with the administrative boards involved, the experimental work in the government agencies. As regards the use of programme budget techniques, the experiences gained are briefly that :

- programme grouping of activity has been based on work methods rather than areas of requirement;
- performance reports exist in some form in quantitative terms. The quality can rarely be considered when measuring results;
- the measurement of productivity is often at fault due to incomplete performance reports;
- cost accounting with regard to programme seems to work well in principle;
- activity planning is not very developed;
- aims are often vaguely formulated and operationalization of target attainment is unusual.

Even if no complete programme budget application has yet been achieved at any of the government agencies involved in experimental programme budgeting the experimental work has contributed positively to the economic-administrative development as a whole. With reference to the experiences gained, the introduction of a complete programme budget system is regarded as a long-term process. The level of ambition must be raised successively with a view to making the system increasingly more effective in achieving its aims.

## Plans regarding the grant system at government level

In 1969 the government appointed a budget commission to draw up a survey of the government budget system, etc. The primary task of this commission is to examine what changes should be made in the government budget system for it to become an effective tool in controlling the use of economic resources and in stabilizing policy.

Last year the commission presented a sub-report containing a proposal for programme budgeting at government and parliament level.

The primary features that the commission considers as essential in a programme budget system at this level are an increased use of aims-means analyses, a more defined allocation of roles to the government and parliament respectively, a division of the national budget on the basis of purpose, increased planning, and demand for performance reports and cost accounting.

The aims-means analysis is considered to be an essential stage in programme budgeting, above all because attention is drawn to the aims and effectiveness of government activity. The budget process can be seen as a balance between various social aims. In view of this, it is considered that aims-means analyses should be used to an increasing extent when classifying budget aims. A primary object in role allocation is that the government and parliament assume increased responsibility for targeting the activities of government agencies while the agencies are accorded greater responsibility for the selection of means of carrying out the tasks imposed upon them.

Apart from constituting bases for budget decisions over a one-year period, it is proposed that planning should also comprise long-term studies of the sectors and programmes. The aim of the sector studies is to outline the future environment - for a period of 10 to 20 years - in which activities will be conducted, to discuss the object of the activities, and to unconditionally indicate alternative aims and organization of the activities. The programme studies will indicate the consequences of decisions already made, and, within various resource limits and on the basis of the perspective studies, will indicate reasonable alternatives for the development of various activities on a five-year basis.

## Summary

Experimental programme budgeting at government agency level has developed so far that it is now possible to evaluate the various effects of programme budgeting as a planning and control system. On the basis of the experiences gained in evaluating this experimental work, it appears that certain aspects of programme budgeting are so demanding that implementation requires a great deal of time.

However, programme budgeting has proved to have many advantages compared to the traditional grant system and, within the context of increased demands for effectiveness and rational methods in public administration, many of the basic ideas inherent in programme budgeting will be tried out in the future in the development of grant systems at government agency level as well as at government and parliament level.

## 2. EXPERIMENTAL PROGRAMME BUDGETING IN HIGHER EDUCATION AND RESEARCH

Experimental programme budgeting in higher education and research comprises only a small part of the total venture. It was initiated at the Chalmers Institute of Technology in 1968 and extended in 1972 to include the college in Linköping, which in 1974 will receive its entire grant in the form of a programme budget grant.

With the inclusion of the college in Linköping, the experimental work has come to cover the technical and medical faculties as well as the faculties of arts and sciences. Placed in relation to higher education's and research's total activities the experimental work covers two of about fifteen universities and colleges and involves about ten per cent of the total grant.

The original object of the experimental programme budgeting in higher education and research was to :

-
- develop a financing system geared to results and suited to higher education and research;
- develop a control system intended for colleges utilizing programme budgeting;
- chart the prerequisites for a decentralization of decision-making regarding higher education and research.

Supervision of the experimental work is exercised partly by a central supervisory group and partly by local supervisory groups. The Ministry of Education and Cultural Affairs' central supervisory group for experimental programme budgeting in higher education and research consists of representatives of the Ministry of Education and Cultural Affairs, the Ministry of Finance and the Ministry of Agriculture, and representatives of the Chalmers Institute of Technology, the college in Linköping, the Office of the Chancellor of the Swedish Universities, and the National Swedish Accounting and Audit Bureau. Each year the central supervisory group draws up the work plan for, and decides on matters connected with the experimental work. The local supervisory groups at the Chalmers Institute of Technology and the college in Linköping are responsible for planning and formulating the experimental work within the framework of the respective colleges. In addition there is a supervisory group in the Office of the Chancellor of the Swedish Universities which has primarily to develop methods of dealing with questions common to all colleges and universities as related to the colleges utilizing programme budgeting.

## Experimental programme budgeting at the Chalmers Institute of Technology

The experimental work at the Chalmers Institute of Technology covers partly the technical faculty and partly certain training and research in the faculties of arts and sciences. In view of this the work has been grouped according to purpose in the following college programmes :

1. Basic technical education;
2. Basic mathematics - natural sciences education ;
3. Technical research and training of researchers;
4. Mathematics - natural science research and graduate training ;
5. Certain administrative tasks (covers service to external authorities).

It is on the basis of the above classification of experimental work that grants are given and planning and follow-up are conducted. This means that the institutions primarily responsible for both education and research are accorded funds from two or more of these college programmes.

The development of routines for a more functional follow-up and planning of activity is an important part of the experimental work, and the results obtained can be summarized as follows :

### Budgeting of costs

A detailed picture of activity with regard to budgeting within the college programme for basic technical education has been formulated with relatively fair certainty. There is no corresponding detailed budgeting for the other programmes.

## Cost follow-up

Book-keeping and follow-up of costs are done in accordance with the common government accounting system. Despite considerable effort, the accounting does not function entirely satisfactorily, according to the original intentions to account for costs on the college programme. This is due to a large extent to the fact that the parties obliged to account for costs, i.e. the institutions, have great difficulty in apportioning the costs between programmes.

## Measurement of results

In co-operation with the Gothenburg Computer Centre, the Chalmers Institute of Technology's educational section has developed a grade computer system in which information regarding basic technical education is stored and processed . This has created a means of routine quantitative measurement of results. For the follow-up of results for other basic education within the college programmes, information regarding students and study results is passed through the arts and science faculties' joint information system.

As bases for planning and following up the work, the college draws up annual work plans for the following fiscal year, a grant statement for the fiscal year after that, and a financial report for the fiscal year ended. The financial plan for the coming fiscal year is drawn up for basic technical education with the aid of institution and course budgets. Otherwise, the educational boards for basic education and the faculties/sections for research and graduate training submit - on the basis of certain principles regarding the allocation of grants which are generally determined by the university council - proposals for the distribution of the grant for the respective college programmes to the university council (the college's board ). Finally, the council determines distribution within the respective college programmes. The intended purpose of the distribution of the grant increase for each respective college programme is given in the financial plan.

Grant application for the following fiscal year is based on the respective college programmes. Detailed information as to the purpose for which the requested grant increase is required is supplied for each college programme.

The financial statement for the fiscal year ended outlines business at the college. On the basis of the college programmes, comments are made on their management, utilization of capacity and performance results,wherever possible.

The Chalmers Institute of Technology has applied experimental programme budgeting for some three years. An application of the principles of programme budgeting at all levels within the Institute has not yet been achieved within the framework of the experimental work. It is therefore important that such a development be continued. The primary information for long-term and short-term planning of work within the framework of the college programmes is obtained at institution level. Therefore properly-functioning cost accounting is required for the college programmes. In view of this, methods of cost accounting should be developed without creating any further administrative work for the institutions.

One of the advantages of programme budgeting is that greater cost consciousness has been created within the college. The institutions have gained increased freedom of action through the right to select the means themselves, within the limits of the resources accorded, in order to achieve the aims set. This has resulted in a more effective utilization of the funds granted.

The experimental work conducted at CTH indicates that programme budgeting can be an administratively onerous method, due to detailed budgeting and accounting which are necessary in order to implement the present method of programme budgeting satisfactorily. The extra work occurs primarily at institutional level. One reason for this is that costs incurred in planning and following up the work must be accounted for each programme. It may often be difficult for the institutions to refer costs to programmes when a large part of them can be listed as joint costs for several programmes. As stated previously, these problems of division create involved administrative work and necessitate extensive training and information.

## Experimental programme budgeting at the college in Linköping

The work at the college in Linköping covers the technical, medical, and arts and science faculties. On 31 January 1972 the Crown ruled that the college in Linköping would start experimental programme budgeting in the technical faculty. This meant that the grant application for the fiscal year 1973/74 was to be formulated in programme terms, and that activities would thereafter be developed with the view of applying programme budgeting. On 19 May 1972 the Crown further decided that the survey of, and experiment with, programme budgeting would be extended to include all faculties. The Crown stated that in this context work should, if possible, be so conducted that the college in Linköping's grant application for the fiscal year 1974/75 be formulated in programme terms.

Work on programme budgeting at the college has consisted of preparations for the coming grant application in programme terms for the entire college.

An important stage in this work was to formulate at institutional level lists of various courses and projects conducted within the framework of basic education and research and graduate training respectively. On the basis of the institutional course and project lists, course and project budgets at institutional level were drawn up. The institutional course and project budgets then formed bases for a completely new formulation of the accounting system and for the grant application.

The grant application for the fiscal year 1974/75 for the college in Linköping was formulated on the basis of a division of work by purpose into the following college programmes :

1. Basic arts, social science and mathematics - natural science education;
2. Basic medical training;
3. Basic technical training;
4. Medical graduate training and research;
5. Technical graduate training and research.

With regard to experimental programme budgeting at the college in Linköping, it is too early to form any conclusions regarding the advantages and difficulties that a division of work by purpose can induce in the various faculty fields. The extension of the experimental work and the fact that the college in Linköping is participating in it has created a more versatile basis for assessing how planning and control, classified by purpose and geared to results, should be formulated to integrate with educational and research activities.

## Summary

Survey and experimental work have been conducted within the sphere of higher education and research for some five years. As yet no particularly lively discussion on the pros and cons of the systems has appeared in the university and college sector. What discussion there is is conducted mainly by the authorities running the experiment and by the various fact-finding groups.

During the trial period certain faults primarily in the prerequisites for the application of the programme budget have become apparent; that is, the difficulties of formulating precise aims, of measuring results and costs of the work.

One of the most important aspects of a completed programme budget system is to indicate and define aims for the work. The aims set within the university and college sector are not developed in such a way that they are entirely satisfactory from the programme budgeting point of view.

They are defined with regard to basic education in quantitative terms, whereas the qualitative aspects have proved more difficult to define.

With regard to research it seems very difficult to determine aims other than in very general terms. It is perhaps neither necessary nor desirable to go into more detail. Furthermore we can also question the value of setting up carefully defined aims within the education and research sectors. In the university and college field there are continuous changes in aims, due to changes in demand for certain types of education as well as changes in society's demands on education and research in general. Aims defined in detail could easily cause sluggishness and constitute an obstacle to renewal.

In the absence of detailed aims the reporting of results and the measurement of effectiveness have a limited value. However, a survey is being conducted at present with a view to developing more appropriate methods of defining and measuring the results of educational activities. In addition to the difficulties mentioned, a division of the work by purpose into programmes creates the problem of distributing costs by programmes. It is often extremely difficult - even impossible - to refer costs - material costs as well as costs of wages - to programmes with any degree of certainty. In this context we have reason to recall that the difficulties involved in formulating aims, measuring performance and dividing costs between various purposes, are as prominent in other budget systems as in experimental programme budgeting.

However, these difficulties have certainly helped to bring the mistakes into the open and thereby draw attention to important problems which must be solved in order to create reliable methods for society's allocation of resources to different sectors.

The positive aspects of experimental budgeting have been judged as being increased cost consciousness, increased freedom with regard to utilization of resources and decentralization of decision-making. Freedom of action within the limits set up with regard to resources plays an important part in permitting a smooth integration of work at the universities with the constantly shifting demands created by the interaction between education/research and society in general. From this point of view the development towards a budget system geared to purpose is valuable.

## 3. PLANS REGARDING THE FORMULATION OF THE FUTURE GRANT SYSTEM FOR HIGHER EDUCATION AND RESEARCH

The question of the future grant system for higher education and research has become very topical since the 1968 Committee on Education recently presented its main report on the extent, structure, organization and localization of post-senior secondary school education to the Crown.

With regard to the organization of higher education and research the Committee's proposals mean in brief that activities will, as regards planning and decision-making, be separated from basic education on the one hand and research and graduate training on the other. Here we will briefly discuss the Committee's proposals for grant systems in the event of a divorce between the executive units responsible for basic education and research/graduate training respectively.

### Proposals for grant systems for the basic education proposed by U 68 (1968 Committee on Education)

In its report the Committee proposes that basic education be divided according to purpose into five sectors :

technology;
administration and economics;
medicine and social work;
teaching;
cultural work and information.

Education within the five sectors of professional training should in addition be primarily divided along general education lines.

In the educational committee's opinion resource planning should be an integral part of the combined educational planning. In accordance with this it is proposed that responsibility for dimensioning education, for organization,content and work forms be decentralized to a considerable extent to the individual colleges' administrations. At various decision levels U 68 presupposes relatively detailed planning and follow-up.

Government considerations regarding resources for future college activity should be formed with a view to purpose, and then various sectors and educational lines in basic education should be examined.

On the basis of grouped planning by purpose and formulation of the grant system that the educational committee proposes, a planning and control system,which is in many ways connected with a programme budget system, will be introduced. Most likely, however - considering the experience gained from the experimental programme budgeting now conducted both within the field of education and in other public administrations - the planning and control system for future basic education will be very simplified compared with those that have been tried within programme budgeting.

Research/graduate training

A separation between the executive units of basic education and of research/graduate training as proposed by the 1968 educational committee will indirectly affect the forms of planning and control of research/graduate training.

With the present grant system for higher education and research apart from the institutions applying experimental programme budgeting, there is no information on how large a part of the universities' resources is utilized for research and for other activities.

On the basis of what is stated in the Government Budget Proposals for 1971, that socio-political aims should dictate the pattern of research and development, a report on resource utilization should be made on the basis of the main aims of research and graduate training at the universities and colleges. This would preferably be in the form of simplified programme budgeting. If a planning system geared to programme budgeting is applied, one of the foremost advantages would be that aims would be defined automatically . This also offers a better means of according priority to various aims. However, the diffuse picture of the acquisition of resources for primarily university research is hardly in accordance with programme budget thinking and the attempts to introduce greater effectiveness. For this reason the Parliamentary Auditors, after examining government research activity, proposed that the present organization for the acquisition of resources for universities and colleges should be supervised.

The following report outlines a system of planning, budgeting and follow-up graduate training and research at universities. One should not think that this system could be applied to any Swedish university without difficulty. A radical re-organisation of the administration of government assistance to university research, for example, would be required. Such a reform also involves a delicate balance between the universities' free basic research and the research supported by the research councils and geared to applied areas. Changes of this nature require considerable time to mature.

The research councils' attitude and method of working has also been under survey for the past year.

Even if this obstacle did not exist, it would still be difficult to apply the system within the administration of one university. It will probably be possible to solve in theory the difficulties involved in defining specific aims for research, in measuring both qualitatively and quantitatively with some degree of accuracy the results of graduate training and university research, and in distributing, at institutions where both basic education and graduate training and research occur, costs between these varying purposes. To apply the theoretical solutions to practical reality can, however, give rise to considerable opposition by administrators as well as by teachers and researchers. The report also emphasizes that problems ~~of this sort~~ exist. The two years' experience of experimental programme budgeting at the Chalmers Institute of Technology which took place between the formulation of the report and this introduction also clearly shows that the extent and importance of these problems have by no means been exaggerated by the authors of the report.

The merits of the report comprise partly the detailed description of the administration of graduate training and research at university institutions, and partly the definition of problems that can, on the basis of this factual material, be made in the theoretical outline. This also brings to the fore the difficulties involved in a transfer from cost classification budgeting to programme budgeting, and allows the discussion of these difficulties to be more open. The experience now gained in Sweden of experimental programme budgeting in higher education and research very clearly indicates that the failures regarding aims definitions, performance measurements, and cost distribution in higher education and research, have also been an obstacle to experimental work with pure programme budgeting.

It is not likely that a programme budget for graduate training and research will actually be applied in the way indicated in the outline sketched in the report. As the above indicates, a development towards a budget system more geared to programme appears likely in the case of higher education and research also. It will be seen as necessary to balance the administrators' and budget experts' demands for a refinement of the budget system and the researchers' and teachers' demands for easy-to-handle administrative routines, all well suited to their work and which will take up little of their time. To achieve a balance of this sort the administrators and budget experts will probably have to produce the budget system outlines that they consider to be ideal, followed by discussions and trials in order to meet the teachers' and researchers' demands. The latter's demands with regard to the budget system should be first sufficiently and concretely formulated so that they can be used to develop such systems and can stand up against criticism from the administrators and budget experts. The following report must be seen as a link in this kind of chain of development, and it is as such that it has its greatest and undeniable value.

# Chapter 1

# INTRODUCTION

## 1. BACKGROUND OF THE PROJECT

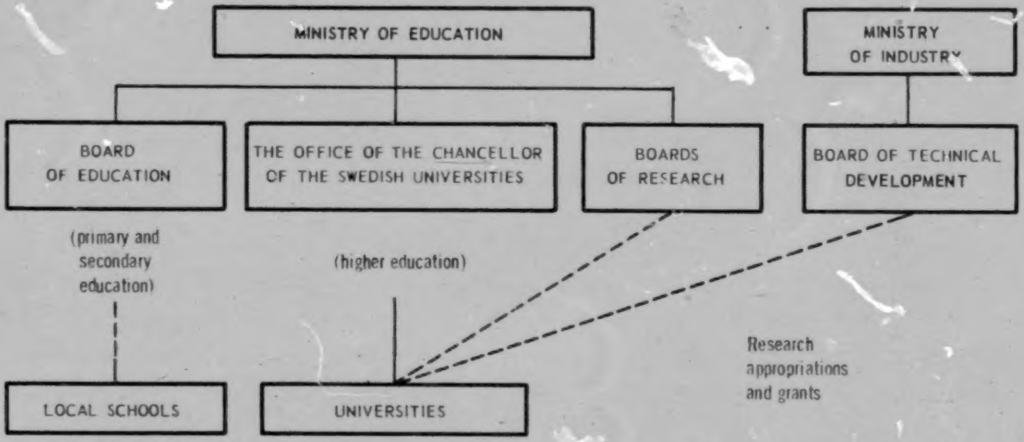
The development of PPBS in Sweden started in 1963 when a committee was established by the Government to investigate the possibilities of using PPBS as modern tools in state administration. The committee was ready in 1967 and presented a report on the principles of programme budgeting and its use in public administration especially for the management at agency level. The committee proposed that a PPBS and cost accounting system should be introduced in state agencies below the government level.

The concept of programme budgeting was defined in the report as follows: "Programme budgeting aims at improving effectiveness by means of creating a system of management which increases the requirements of economic thinking and economic responsibility at all levels". This means primarily that the goals should be specified in programmes for each agency. In order to attain these goals the Government provides goal-directed appropriations for the different programmes. The basis for the budgeting will consist of quantifying the tasks to be carried out by the agencies and the costs arising thereby. The agencies are to be provided with considerable freedom, within the pre-determined framework, to choose those means, in the form of different factors of production which produce the best results.

The Government decided early in 1968 that pilot studies using programme budgeting would be extended to 23 agencies representing every department in the Government. The Office of Chancellor of the Swedish Universities was among the selected agencies for launching a PB pilot study. In order to build the PB system "from the bottom up", Chalmers University of Technology was chosen as the institution where a field pilot study could be launched.

The development of the PB system in the sector of higher education and research is directed by a "control group" attached to the Ministry of Education. Working groups have also been established at the Office of the Chancellor and at Chalmers University of Technology to lead the PB activities at each level.

Before describing the activities within the project since 1968 and the present status of the Chalmers University PB pilot study, a brief summary of the Swedish university system should perhaps be given.


MINISTRY OF EDUCATION
MINISTRY OF INDUSTRY
BOARD OF EDUCATION
THE OFFICE OF THE CHANCELLOR OF THE SWEDISH UNIVERSITIES
BOARDS OF RESEARCH
BOARD OF TECHNICAL DEVELOPMENT
(primary and secondary education)
(higher education)
Research appropriations and grants
LOCAL SCHOOLS
UNIVERSITIES

The Office of the Chancellor of the Swedish Universities functions as a planning and investigating governmental office. It is organised into five Departments :

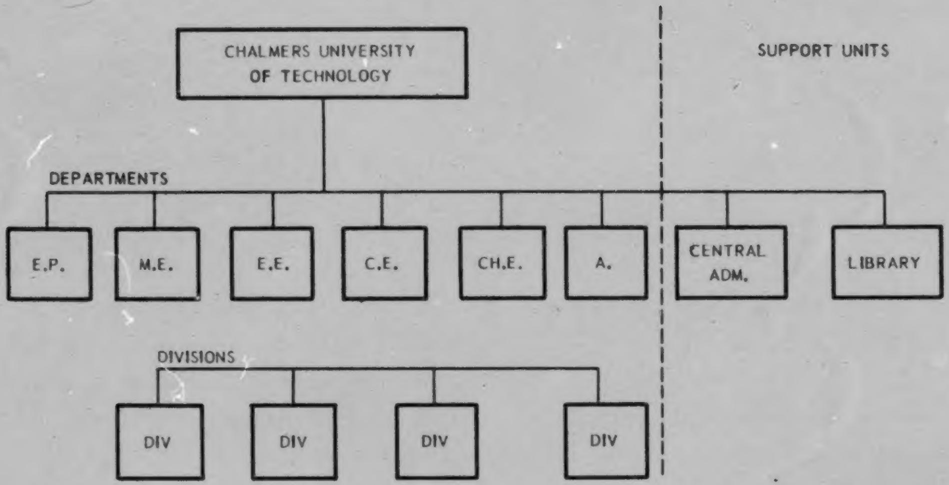
1. Planning
2. Training
3. Educational Planning and Research
4. Administration and Organization
5. Management and Auditing.

Representatives of commercial and industrial sectors, professional organisations, administration, teachers and students, etc., are associated to the Office through the Faculty Planning Boards which among other things have to give their opinion on the university budget requests. The Office of the Chancellor is also responsible for the various educational plans and for providing a uniform educational system at the different institutions.

One of the universities is Chalmers University of Technology (CTH). The university consists of six departments and its organisation is shown in the chart below ;

1. Engineering Physics
2. Mechanical and Naval Engineering
3. Electrical Engineering

4. Civil Engineering
5. Chemical Engineering
6. Architecture.


CHALMERS UNIVERSITY OF TECHNOLOGY
SUPPORT UNITS
DEPARTMENTS
E.P.
M.E.
E.E.
C.E.
CH.E.
A.
CENTRAL ADM.
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## 2. OUTLINE OF THE PROJECT

The development of a Programme Budgeting System at Chalmers University of Technology has three main objectives, according to the general philosophy of the Swedish PB system :

- to develop an output-oriented finance methodology applicable to the Swedish university system;
- to develop a modern management methodology applicable to a "PB university";
- to find possibilities for changing the decision-making structure outside and inside the universities in a decentralised and "democratic" direction.

The Project is divided into three phases :

Phase 1 : Overview and definition of graduate training and research activities at the University (2 months).
Phase 2 : Analysis of the input factors and output measures together with a study of the organization of research and training (2 months).

Phase 3 : Construction of a preliminary university-wide PPB framework for graduate training and research to be tested in the subsequent budgeting processes (2 months).

A detailed description for each phase is given below :

### Phase 1 : Overview and definition of graduate training and research activities at the University

At the outset it is proposed to carry out a general review of the problems of graduate training and research and to survey the work in programme budgeting in this field in Sweden and other countries. Such an overview will also include the legal and organizational aspects of graduate training and research in Sweden, the structure of the financing of such research activities in Sweden and in other universities, and a review of the goals formulated by educational authorities in Sweden. Furthermore, it will be necessary to examine the respective roles of the Office of the Chancellor, Councils of research, industry, etc., as they affect the activities of graduate training and research.

Within the Chalmers University of Technology this phase will involve the identification of ongoing and planned research activities as well as graduate training activities (for example, graduate curricula, thesis work, supervision). This could lead to a classification of different activities in this field which could then be used in the second phase which involves pilot testing. In addition, it will possible to develop preliminary hypotheses regarding how the activities so classified utilise the various input factors. Particular emphasis will be given to the interrelationships between different activities, such as the effect of the participation of students in research activities upon their educational performance.

### Phase 2 : Analysis on the input factors and output measures together with a study of the organization of research and training

The second phase will involve a selection of two or more divisions within the University in order to carry out pilot developmental work on a programme budgeting framework, which will eventually be proposed for the university as a whole. The choice of the divisions will be made in order to get a contrasting picture with regard to the size of the division and the direction of research (for example basic versus applied). This choice will depend upon discussions with responsible officials within the University and particularly within the divisions.

During this pilot investigation an analysis will be carried out of the input volume of different factors, such as different categories of academic staff, non-academic personnel, computer time, support activities and other expenditures on equipment and supplies. Such an analysis of input factors will cover both physical and financial inputs. In the first case special analysis will be undertaken of the input of teacher and student time for graduate training and research activities. A preliminary and partial time utilisation survey has already been designed and is now being carried out on the staff of the University. The analysis of the financial inputs will also include a close examination of the sources of funding for research activities and particularly the effect of external funding on teaching and research.

A particularly difficult aspect of programme budgeting which needs attention is the development of output measures for graduate training and research. Here an attempt will be made to develop output measures for each of the activities identified for the divisions selected. It is believed that work at divisional level within the University will provide a better basis for developing output measures that are operational.

In order to better understand the relationships between inputs and outputs of the system it will be necessary to examine the organization and process of graduate training and research. By this is meant such factors as size of class, use of research assistants for teaching, the alternative uses of physical facilities for teaching and research, etc. The study also includes an examination of the requirements of the various support activities for carrying out research and graduate training.

The field work in the selected divisions will provide an opportunity for :

a) testing a number of hypotheses developed in the earlier phases, particularly with regard to the interrelationships of activities; and
b) refining the classification of activities in the field of graduate training and research.

### Phase 3 : Construction of a preliminary university-wide PPB framework for graduate training and research to be tested in the subsequent budgeting processes

The work carried out in the selected divisions of the University should provide a basis for the formulation of a programme budgeting framework for the University as a whole and for graduate training and research activities.

Developing such a framework would involve work in two directions : firstly, the elaboration of the PPB framework and secondly, the specification of information requirements to implement such a framework.

With regard to the first direction, a number of steps will have to be carried out. These steps are :

a) specification of goals for graduate training and research for the Chalmers University of Technology in terms of assumed sets of national goals for this sector resulting from the work of the Swedish Ministry of Education;
b) a definition of programmes and activities with a view towards determining the practicability of separating out research from graduate training;
c) formulation of objectives for each programme and sub-programme on the basis of discussions with a work group on programme budgeting at the University, as well as with the Steering Committee of the Ministry of Education; and
d) development of a framework of output measures for the various programmes in terms of their objectives, consistent with the programme budgeting framework.

These steps will lead to a preliminary "model" which will be examined in terms of its relationship to current budgeting procedures and other activities, such as physical plant and facilities planning.

The second direction of work during this phase will involve the information needs of the PPB framework in terms of existing information, as well as additional information required. These needs will be spelled out in terms of :

a) financial information (programme costs of different activities and final estimates of inputs); and
b) quantitative and qualitative information (number and type of graduate students, teaching loads, time distribution of staff and students, level of teaching, etc.).

The examination will cover the possibilities of collecting the abovementioned types of information as part of the regular planning and budgeting procedure, and the development of methods and procedures for collecting additional information specifically required in programme budgeting.

## 3. CHRONOLOGICAL DESCRIPTION OF THE PB PROJECT AT CHALMERS AND DISPOSITION OF THE PROJECT

### Setting up a project organisation (Summer 1968)

The project started in the summer of 1968 with the setting up of a comprehensive project organisation. The project was commissioned by the Ministry of Education and from that level supervised by a "PB Control Group". The Office of the Chancellor, responsible for the project operations, extended the project to CTH from the beginning. Since the summer of 1968 four persons on the average have been working on the project or with questions closely related to it, and half of this staff has been working at CTH. In order to lead the project activities at CTH a "PB working group" was established, consisting of the following members : Rector (chairman), 2 professors, Head of the Central Administration, Heads of the Departments of Educational Planning, Administration, and Planning plus staff members. The staff of the project is attached to the Department of Planning at the Central Administration.

### Two divisions were selected for pilot studies (Autumn 1968)

The economic-administrative structure within the universities was rather unknown when the project started. In order to provide better knowledge of this structure, two divisions, the Division of Physics and the Division of Control Engineering, were selected. In our first project report in December 1968 a detailed analysis of these two divisions was presented, comprising their organisation, costs and resources, activities and outputs. We tried in this analysis to use the common PB concepts as defined in the general guidelines submitted by the Ministry of Finance.

In this first report more general discussions concerning the objectives and extension of programme budgeting were introduced, especially which costs the PPBS should comprise. In the initial phase it was obvious that only salary costs and current expenditures of the programmes could be calculated in the "output-oriented appropriation system". Other costs, such as that for computer time, investments and capital expenses for equipment and buildings were planned to be covered by the system at a later stage, due to the special conditions and restrictions related to these costs.

### Design of university-wide cost-accounting and budgeting systems (Spring 1969)

The analysis of the different activities and objectives made it possible to establish a preliminary programme structure. With this as a basis the budgeting system and the cost-accounting system could be developed.

During the spring of 1969 an EDP cost-accounting system was designed and implemented beginning 1 July 1969.

## Internal budgeting procedure (Autumn 1969)

An internal budget procedure, related to this cost-accounting system, was applied during the summer and autumn of 1969. The entire division participated in this budgeting work with good results as to the possibility of introducing new management tools and purposes of PPBS to the professionals within the university. The theory of cost-effectiveness was in general accepted within the university.

## Construction of a PB proposal model (Spring 1970)

With the budget figures taken from the internal budget a Programme Budget Proposal could be submitted to the Office of the Chancellor. The design of the PB proposal followed a Budget Model for the university. In this proposal we made an attempt to show how the outputs of various kinds could be quantified in the undergraduate programme. We soon found that the output-information that the present information systems could provide us with did not satisfy our needs and therefore the development of an ambitious Student Data System, which had already been started, was given top priority.

The presentation of the Graduate Training and Research programme was not especially elaborated in this first PB proposal as regards to the methodological framework of PPBS. Many problems had to be left unsolved and we have only recently been able to examine these questions again in the CERI/OECD sponsored project.

## Revision of the cost-accounting EDP system (Spring 1970)

In the spring of 1970 a new cost-accounting data system was implemented, the SEA-system, which is an administrative management data system which most agencies in Sweden will adopt.

## Analysis of the internal planning system (Autumn 1970)

The internal planning system was carefully examined in the autumn of 1970, together with a general analysis of the decision structure at various levels of the university. These analyses led to considerable progress in establishing an outline for an organisational framework that would serve the demands of PPBS. The main purpose related to the organisational design is to establish a management system where the various programmes and subprogrammes at different levels correspond to responsible units within the university - Programme Units. The objectives of the Programme Units are primarily to optimise the effectiveness of their programmes, both in the planning phase and in the resource-allocating phase. A Programme Unit receives an output-oriented appropriation to accomplish the objectives of the programme by allocating the resources to a Sub-Programme Unit at a lower level by stating the output requirements and financial frames. The Programme Units should also be responsible for the performance control. In this way, when the responsibility for the output and performance of the programmes is focused on responsible units , it will in our opinion be possible to improve their effectiveness and economic behaviour.

On the basis of the budget figures prepared in our earlier PB proposals, the Government, in the Government Bill, proposed to the Parliament that CTH should obtain programme - or output - oriented appropriations for the fiscal year 1971/72. This suggestion was followed by a Royal Regulation Letter in programme terms. The new design of the appropriation system activated the PB development at CTH, and the spring of 1971 was devoted to refining the resource-allocating methods following the principles of PPBS.

## Internal resource-allocation (Spring 1971)

This first internal resource allocation of the programme appropriations could not be performed in the extreme output-oriented way desired in our planning. The budget figures and the cost-accounting information were not of high enough quality to apply it as the only basis for allocating the resources to programmes, sub-programmes and projects without any relation to the former budgeting system, in which the departments in general, not the programmes, received the appropriations. The reason for the difficulties is that the PPBS at CTH assume a matrix-organisation in which the programmes are acting over departments in a completely free manner. One programme could comprise items from several departments, which makes the programme budgets more complicated to establish. It will be some time before the participants in different programmes and department levels have total confidence in the budget figures and the cost-accounting methods. This stability has not yet been achieved and therefore the allocation of resources has been a mixture of classical and programme budgeting.

## Revision of the cost-accounting and budget principles (Spring and Summer 1971)

The difficulties in the allocation process together with other experiences from the cost-accounting methods called for a revision of the budget procedure and the cost-accounting system. An additional reason for this revision were the preliminary results from the Graduate Training and Research pilot study, which contributed to knowledge on how to handle the Research Programme in the PPBS. The requirements that theoretically must be fulfilled are as follows :

- The definitions of the activities must be unique, that is, one given activity should belong to one programme by definition.
- The cost-accounting system must be designed in such a way that the costs can be readily and pragmatically assigned to an activity. Difficult cost-distribution problems and situations of uncertain budget estimates should be avoided by constructing operational principles and standards.

On the first point, the problem is put into focus when, for example, an activity could be connected either to the Research Programme or to the Graduate Training. A clear definition that an activity is connected to a certain programme is better than a more hypothetical but uncertain definition that leaves possibilities to individual judgements.

### What is the cost ?

As far the second point is concerned, the cost-accounting could often raise problems closely related to economic theory. What is the cost ?

Situations with marginal or additional costs for one activity in relation to another are rather common in cost-determinations and the problem is to decide which activity is to carry the fixed costs. The marginal cost principle and the full-cost principle always compete. To make the situation more operational, our experience is that :

- each type of activity must be defined if the marginal cost method or the full-cost method is to be used when determining costs.
- the marginal cost method is preferable on account of its simplicity both in costing and in management.

In the following chapters, the present status of the PPBS is described.

The structure of the report follows the basic division of the project into phases. Thus the first three chapters (2-4) are devoted to an overview of programme budgeting, an analysis of the national and local organization for higher education and research and an economic review of the programme activities at Chalmers University of Technology. The following two chapters are an account of phase II - the pilot study. The report is concluded by a presentation of our proposed PPB-model and an outline of a complementing information system.

Chapter 2 defines the basic concepts of programme budget theory, such as productivity and effectiveness. The relationships between goals, subgoals and programmes are explained and the concepts are related to the planning system and the requirements of the organization. Five elementary PPBS criteria for evaluating the organization are presented and these criteria are later applied in Chapter 3 to the present decision system.

The main part of Chapter 3 is a description of the present organization for graduate training and research in Sweden and of the official goals for these programmes. Our analysis and criticism of the present organization are based on the requirements raised by the programme budget theory. Special attention is paid to the fact that a number of central agencies allocate different types of resources to the same activities at the university, thus being, to different degrees, responsible for the same programme. Chapter 3 is concluded by a review of recent reports in the field of organization of research and higher education.

Chapter 4 gives quantitative relations at Chalmers University of Technology illustrating the situation described in Chapter 3. The main chapter contains a description of sources and basic definitions and should be studied before any conclusions are drawn from the tables in Appendix I. Some important relationships between the main programmes, undergraduate education, graduate training and technical research should be noticed, and we wish to stress the fact that these programmes are clearly interrelated with regards to economic input as well as performance level.

The pilot study of three divisions at the university is presented in Chapter 5. The survey is divided into time utilization, cost accounting, space and equipment, and output measures. The results from the survey for one of the divisions have been put in Appendix II B. A comparison of the results of the pilot study with overall figures for the university have been made in Appendix II C. It is dangerous to draw any general conclusions from a confined study such as this. We prefer, therefore, to add explanatory comments to the tables. The role of the research councils is especially accentuated since their contribution is of prime importance to the PPB-model for the research programme.

The shortage of time limited our ambitions of "measuring" the output of the research programme. However, we were often involved during the project work in discussions and seminars on this subject. A report on possible output measures that have been subject to analysis, is given in Chapter 6.

In Chapter 7 there is the description of our proposed P[illegible]-model to be applied to Higher Education and Research. A discussion on the [illegible]ls of the principal programmes of the university and on the financing system precedes the description of the organization of decisions and the planning system. The decision structure presented is designed to satisfy the basic requirements of a PPB-system. As a conclusion of this chapter an analysis of what changes in the present organization the proposed model will require and a plan of action on how this could be performed, as well as which possible adjustments of the model are necessary due to institutional circumstances, are given.

In Chapter 8 we investigate the consequences of the PPB-model introduced by applying decision analysis to the university system. The university is divided into decision fields and these fields are tied together through hierarchical models which form the basis for the development of an integrated information system.

## Chapter 2

## BASIC CONCEPTS OF PPBS

The aim of this chapter is to describe briefly the definitions of PPBS used in its introduction in Sweden and in the area of higher education and research in particular.

### 1. THE AIM OF PPBS - EFFECTIVENESS IN PUBLIC ADMINISTRATION

The principal aim of PPBS is to improve effectiveness in public administration . In general the activities in the public sector arise directly or indirectly from demand from the private sector or "society". This demand aims to fulfil certain goals in society. It is of greatest importance that the activities of the public sector be placed in relation to the initial demand of society by judging the effects of public activities, corresponding goals of society.

Effectiveness is defined as the benefit of an activity to the goals of society in relation to the total costs of the activity.

Efficiency or productivity is defined as the relationship between performance or primary outputs of an activity and the actual cost of the activity. The efficiency concept is used in a more narrow sense than the concept of effectiveness.

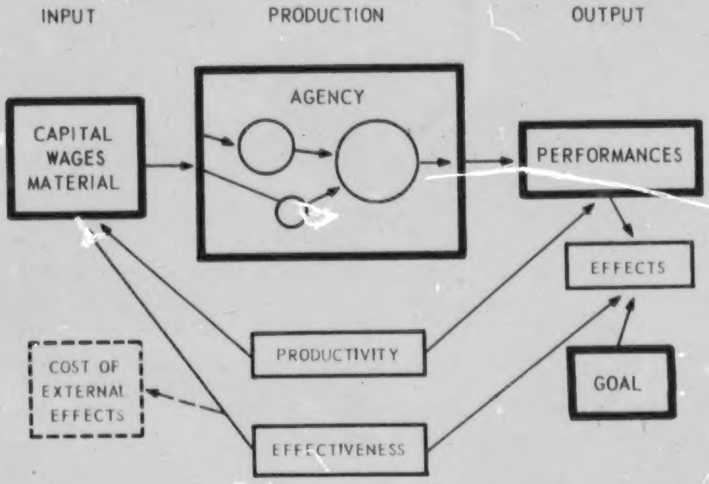
In PPBS the inputs of resources and the outputs of various kinds of performance and effects should be the main criteria for evaluating the relevance of an activity to the goal in question.

### 2. GOALS AND OBJECTIVES

A public unit will always act to fulfil some of the goals of society. The complexity of the public sector however will sometimes make it difficult to realize directly which goal a unit will attain. For practical reasons the goals have to be broken down into sub-goals and objectives.

Figure 2.1

MODEL FOR EVALUATION OF GOVERNMENT ACTIVITIES


INPUT
PRODUCTION
OUTPUT
AGENCY
CAPITAL
WAGES
MATERIAL
PERFORMANCES
EFFECTS
PRODUCTIVITY
GOAL
COST OF
EXTERNAL
EFFECTS
EFFECTIVENESS

In many cases an activity will satisfy more than one goal, which could lead to problems when several goals counteract each other. In short-term decision-making in PPBS this situation is proposed to be solved by setting objectives that make one of the goals dominant or independent ; the minimum requirements of the other goals are built in as a restriction in the objective of the programme.

Should the authorities of the university sector centralize to fulfil the goal of effectiveness of their own sector (1) or should one take into consideration the dependent variable - implications on the labour market of a centralization ? The authorities could handle this problem of conflicting goals by adding demand from the labour market as a restriction in the model.

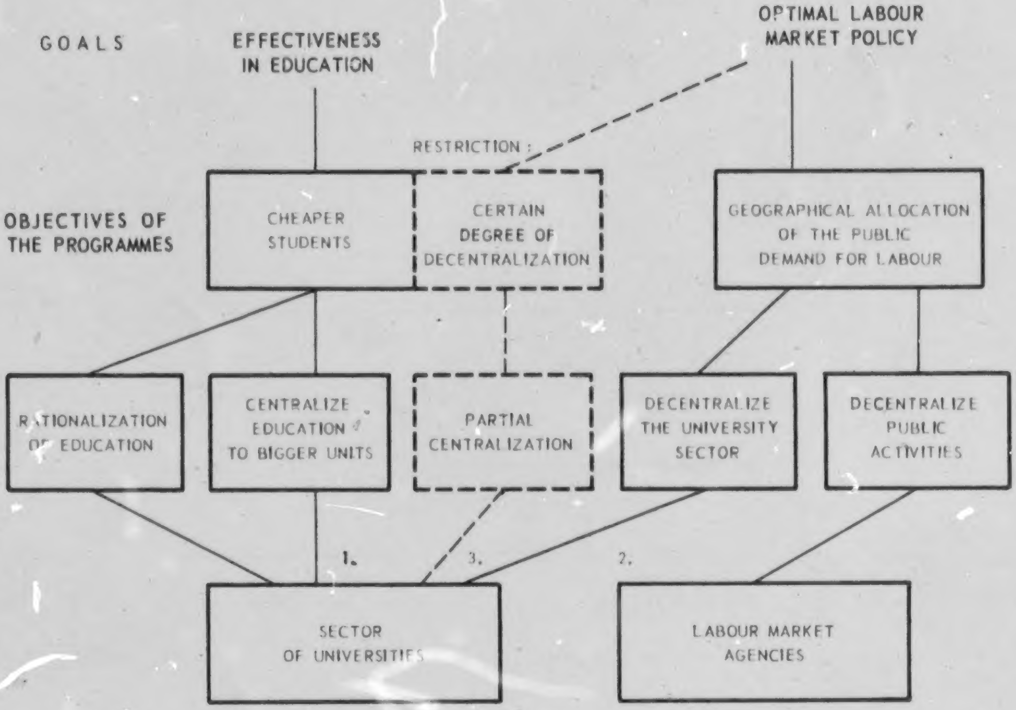
In this way the multi-goal problem could be solved by adding in more and more restrictions in the decision situation which could, of course, become rather complex.

## 3. PROGRAMMES AND GOALS

For each unit, agency or area of the public sector, goals, sub-goals and objectives can be formulated. The goals of unit will, according to the discussion in section 2 above, form the programmes of the unit.

Figure 2.2

CONFLICTING GOALS


GOALS
EFFECTIVENESS IN EDUCATION
OPTIMAL LABOUR MARKET POLICY
RESTRICTION :
OBJECTIVES OF THE PROGRAMMES
CHEAPER STUDENTS
CERTAIN DEGREE OF DECENTRALIZATION
GEOGRAPHICAL ALLOCATION OF THE PUBLIC DEMAND FOR LABOUR
RATIONALIZATION OF EDUCATION
CENTRALIZE EDUCATION TO BIGGER UNITS
PARTIAL CENTRALIZATION
DECENTRALIZE THE UNIVERSITY SECTOR
DECENTRALIZE PUBLIC ACTIVITIES
1.
3.
2.
SECTOR OF UNIVERSITIES
LABOUR MARKET AGENCIES

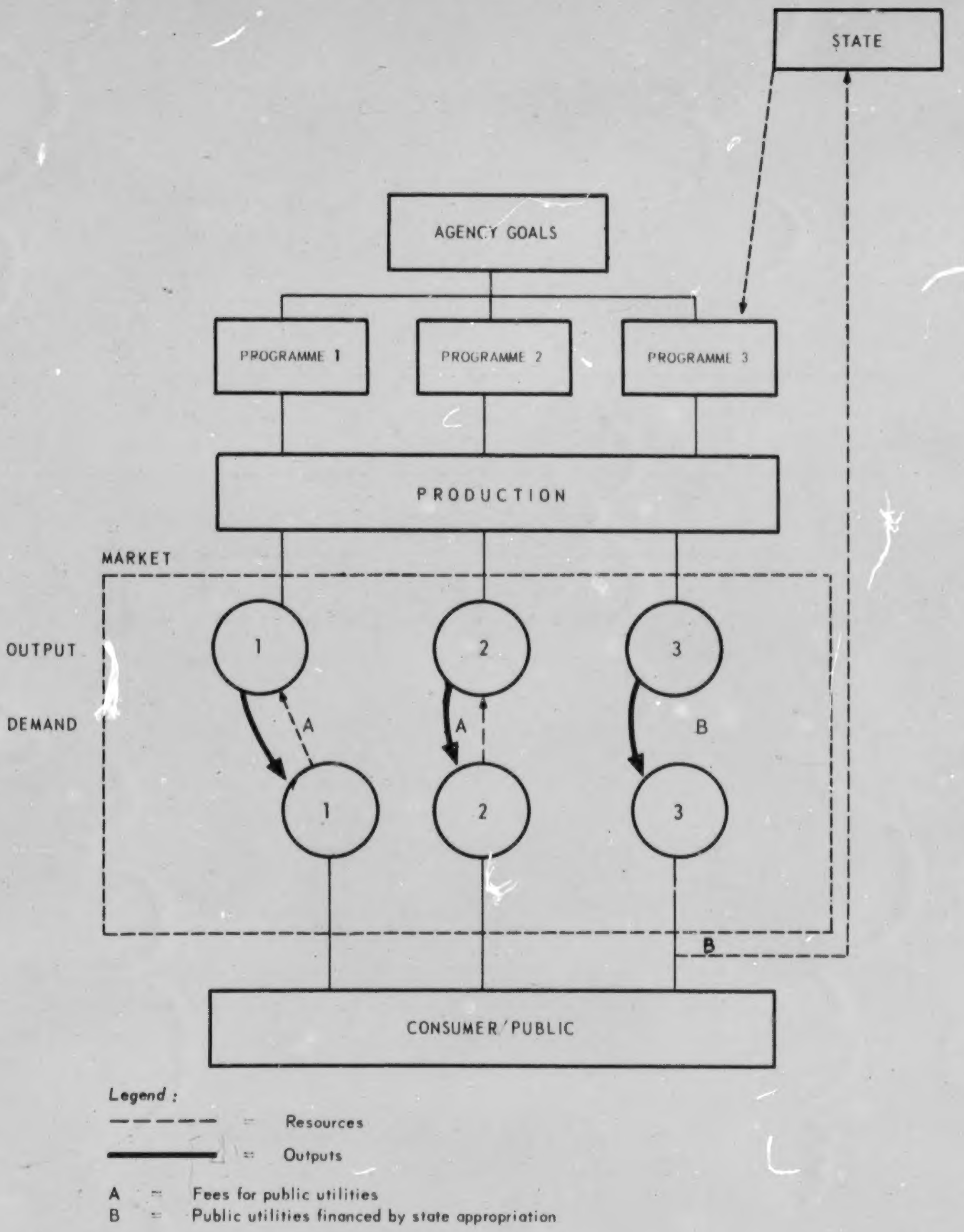
The goals and the programmes of unit (agency) need not necessarily be directly related to the primary goals arising from the demand of the private sector - a unit could serve indirect demands due to activities within the public sector. Hence, many agencies could be considered as assistant agencies whose goals are related to activities within the public sector. The distance between agency objectives and primary goals of society could in many case be very long.

The programmes follow the goals of the unit and, as shown above, the goals-structure could be very complex - one programme or sub-programme could serve several goals. If a presentation of activities that serve a certain alternative goal is needed this could be done by "cross-classification" of the activities in question.

When programmes are formulated for the agency we can say that the agency is responsible for the fulfilment of the goals of the programmes. The objective of such a relation is that someone in the system must be responsible for e.g. bad performance of a programme. This will create the

Figure 2.3

PRINCIPLES OF FINANCING IN PPBS


STATE
AGENCY GOALS
PROGRAMME 1
PROGRAMME 2
PROGRAMME 3
PRODUCTION
MARKET
OUTPUT
DEMAND
1
2
3
A
A
B
1
2
3
B
CONSUMER/PUBLIC
Legend :
= Resources
= Outputs
A = Fees for public utilities
B = Public utilities financed by state appropriation

feeling of responsibility for the output in public administration and lead to better economic behaviour.

## 4. RESOURCE ALLOCATION

The financing of a programme could follow two major principles :

i) financing by direct fees;
ii) financing by state appropriations.

Programmes 1 and 2 are financed by direct fees and programme 3 is financed by state appropriations through taxes.

Looking at the situation presented above, we find that programmes 1 and 2 are self-regulated by the demand of consumers who in a direct way could influence the performance of the programmes. The regulation of programme 3 on the other hand has to be done within the public sector, by, for example, state appropriations. The most difficult thing is perhaps how the authorities should "feel" the nature of the demand from society. As a main principle one can say that the more the local productive unit can regulate the programme by getting feed-back information from the "market" the better the programme will be adopted to the (local) needs of the market. If, however, the shape of the programme due to political reasons is treated by central agencies, one runs a great risk that the demands of the "market" will not be satisfied. A high degree of centralization can on the other hand lead to better *optimization* of the programme.

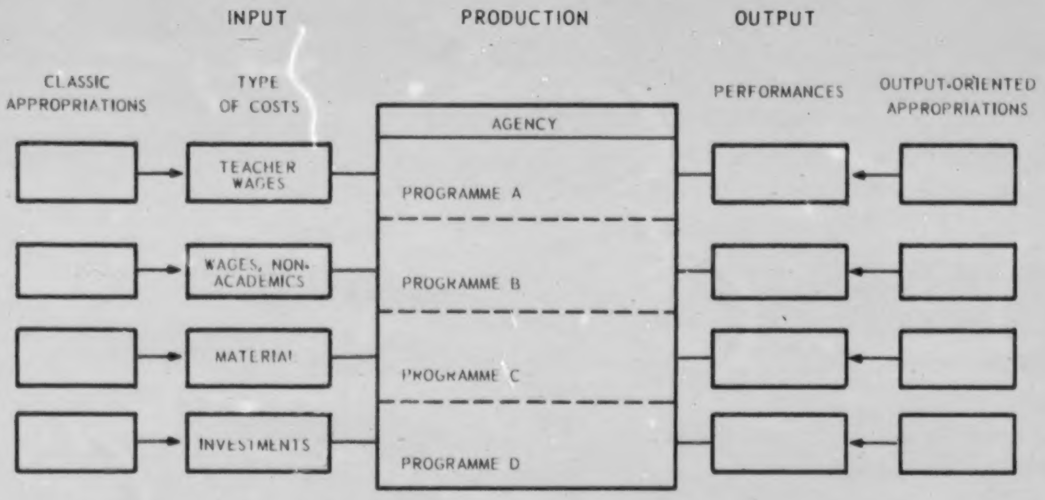
In our case and for PPBS methodology, the system of state appropriation is the most interesting because the activities of the universities are mainly not self-regulating. In a financing system of PPBS *the appropriation should follow the programmes*, that is, one state appropriation for each programme. The government will pay for the execution of certain programmes with defined requirements of output rather than pay the unit their costs. The appropriations are output-oriented,not input-related as hitherto. The figure below will show the difference.

## 5. OUTPUT

When we say that the financing should follow the outputs of the programmes we mean in general that more quality and quantity of output should be paid better than less. This calls for a presentation of the outputs of the programmes.

Figure 2.4

CLASSIC INPUT-APPROPRIATIONS VERSUS OUTPUT-ORIENTED APPROPRIATIONS IN THE PPBS


INPUT
PRODUCTION
OUTPUT
CLASSIC APPROPRIATIONS
TYPE OF COSTS
PERFORMANCES
OUTPUT-ORIENTED APPROPRIATIONS
AGENCY
TEACHER WAGES
PROGRAMME A
WAGES, NON-ACADEMICS
PROGRAMME B
MATERIAL
PROGRAMME C
INVESTMENTS
PROGRAMME D

It quite often occurred that this could not be done in a relevant way, that is,with an output concept that covers the total object of the programme. Operational objectives could be used to a certain extent but mostly in short-term planning.

In all decisions and planning activities information is needed. Decisions concerning a programme need "programme information" about its outputs and inputs. The output (or the benefit to the goals) could be expressed in many ways. A rational way is to present the output in quantitative measures. Another is to give a detailed description of the products. For rational decision-making the quantitative method is preferred by PPBS because of the simplicity such a concept gives decision-makers. However it should be pointed out quite clearly that output measures are not an obligation at all for the success of PPBS. The only thing one wants to achieve with such measures is to have a rational description of the output of the programmes and the alternative ways it could be done. In many cases even an output measure could be very confusing due to limitations and irrelevance of such rough measures.

## 6. PROGRAMME PLANNING SYSTEM

Thinking and acting in terms of programme requires an adequate programme planning system . The aim of such a planning system is to give decision-makers or planning units information concerning the programmes in the first place. Thus the planning shall primarily be programme-oriented, comprising information of inputs and outputs of programmes or programme-parts at different organizational levels and various time-periods.

Examples of planning information are the budget requests, outcome reports, etc. Such information should in PPBS be programmes or output-oriented because the principal decisions are to be made in programme terms. The information of the programmes such as outputs of various kinds and inputs in financial and physical terms, impacts of the performance on special items, are brought together in alternative programme plans according to the objectives of the programme in question. For collecting information for the planning system information systems are needed. Computerized information systems are often introduced and at present EDP is used in cost accounting, output measurement, physical planning, etc.

## 7. REQUIREMENTS FOR THE ORGANIZATION OF PPBS

In PPBS, saying that an organizational unit has a goal or objective to fulfil means that the unit is responsible for the performance of the programme. This should be applied in PPBS at all organizational levels. A national agency is responsible for the fulfilment of the total objective of a programme; executive units at lower levels are responsible for parts of the programme and so on. The extent of a unit's responsibility for a programme is in principle stated by the higher unit which formulates :

- output requirements (expected performance);
- financial and other input limitations;
- administrative rules and management restrictions.

Another most important factor is that a unit responsible for a programme must have most of the means to control the "programme area". That is, no other unit should have means to control activities, or any part of another unit's programme. Total resources for the fulfilment of the programme should be given by the programme authority and the allocations of the resources should consequently follow the hierarchy of the programme.

Furthermore, in the planning system the information for the principal decisions must primarily be given to the responsible programme units...

Finally, a general requirement of the programme units is that they should have capacity, experience and skills to make good programme decisions, that is, the programme units must be designed and organized to fit the tasks of the unit. Good information only is not enough for making good decisions. A well-designed and experienced decision-body is perhaps more necessary.

## 8. SUMMARY

The aim of PPBS is to improve effectiveness in public administration by means of better economic decisions and behaviour.

The demand from the private sector of the economy formulates goals for the public administration. These goals can be broken down into sub-goals and objectives of organizational units.

The goals or the objectives form the programme of an area of action for a unit. Goals can be conflicting but the most suitable classification of the programmes must be chosen.

The financing of public activities could be either by state appropriations or direct fees. In our discussion the former is relevant. The appropriations should follow the programmes.

Output measures or more generally output information are to be used when judging the effectiveness and productivity of the programmes.

A planning system should be designed so that the principal streams of information are focused towards the various plans concerned in the programmes, sub-programmes, etc. Therefore, various information systems are needed.

The organizational framework should be designed so that programme-responsible units are established at all programme levels. The programme unit is responsible for the performance of the programme(s) and a programme shall be related to a responsible unit at each level.

### Synthesis of PPBS requirements on its organization - five criteria.

As a consequence of programme budgeting certain requirements on the organizational units must be satisfied and five criteria for a good organization could be set up for further analysis.

1. The programme unit (e.g. state agency) shall be responsible for the performance of one or several programmes. The objectives of these programmes shall be defined in a distinct and logical way in order to avoid conflicts regarding areas of responsibility towards other programmes and organizational units. The objectives of the programmes should futhermore be related to the general goals and contradic-

tory items such as conflicting goals (multi-goals) should be analyzed and taken into consideration when formulating the objectives.

2. The (programme) unit shall in principle have all the necessary means relative to its responsibility for controlling and planning the total programme area. Such means for controlling the programme activities could for example be resource allocation, formulation of objectives and output requirement to lower executive units and formulation of certain administrative restrictions. The means of a programme unit - controlling variables - shall consequently not interfere with other programmes or activities "belonging" to other areas of responsibility.

3. In order to use the means and to make good programme-decisions, relevant information from the programme parts is needed. The information shall cover the whole programme and not parts or segments of it.

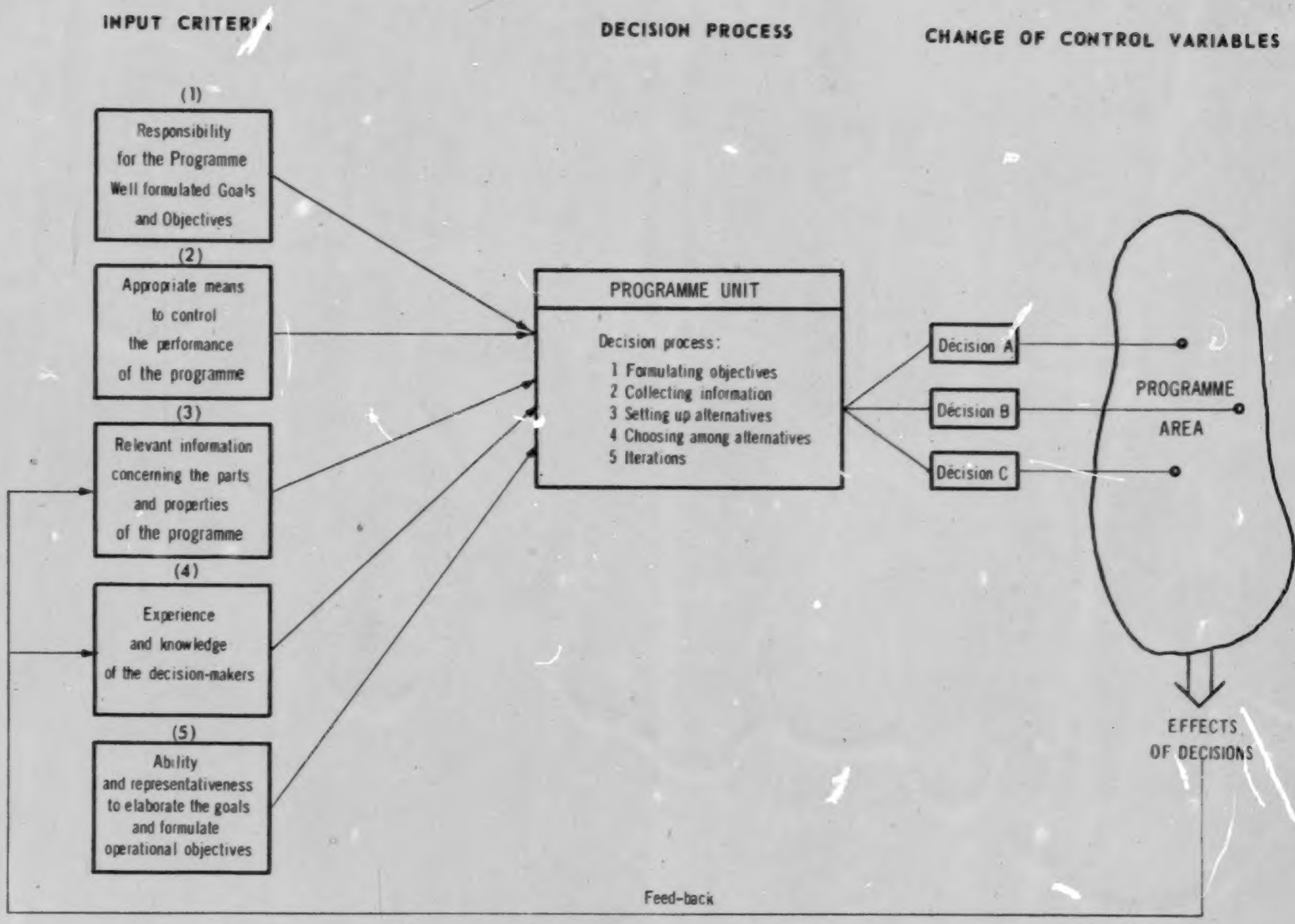
4. Given information, the decision-makers within the programme unit, or the programme unit as a whole, must have the capacity and the experience to evaluate possible alternatives of action and their impact on the programmes. Therefore, expert decision-makers are needed.

5. The decision-makers shall have the ability to choose "the right alternative" according to the goals and objectives of the programmes especially for questions where the goals are not satisfactorily formulated. The decision-makers must therefore be able to identify themselves with the goals. Such decision problems are often solved by establishing decision units where the participants serve as "representatives of the goals". Representative decision-makers are needed.

The decision process of a programme unit may be illustrated as follows (Figure 2.5).

Figure 2.5

THE DECISION PROCESS OF A PROGRAMME UNIT


INPUT CRITERIA
DECISION PROCESS
CHANGE OF CONTROL VARIABLES
(1)
Responsibility for the Programme Well formulated Goals and Objectives
(2)
Appropriate means to control the performance of the programme
(3)
Relevant information concerning the parts and properties of the programme
(4)
Experience and knowledge of the decision-makers
(5)
Ability and representativeness to elaborate the goals and formulate operational objectives
PROGRAMME UNIT
Decision process:
1 Formulating objectives
2 Collecting information
3 Setting up alternatives
4 Choosing among alternatives
5 Iterations
Décision A
Décision B
Décision C
PROGRAMME AREA
EFFECTS OF DECISIONS
Feed-back

## Chapter 3

## THE ORGANIZATION OF GRADUATE TRAINING AND RESEARCH IN SWEDEN

### 1. INTRODUCTION

In this chapter the present organization of Graduate Training and Research in Sweden will be described in terms of budgeting and allocation of resources and in terms of the formal responsibilities for the goals of the graduate training and research programme. Since a programme budget model has a great impact on organization there will be reason to point out certain disadvantages, especially regarding the coupling between goals, resources and output.

We face a somewhat complicated organizational picture. It is rather easy to trace the lines that the subsidies follow. However, it is not always clear who is responsible for the programme of activities within the different fields of research. Thus, in the following description of the organization we are primarily interested in two aspects concerning the authorities :

i) the area and the extent of their responsibility;
ii) the means of control which the authorities are in charge of.

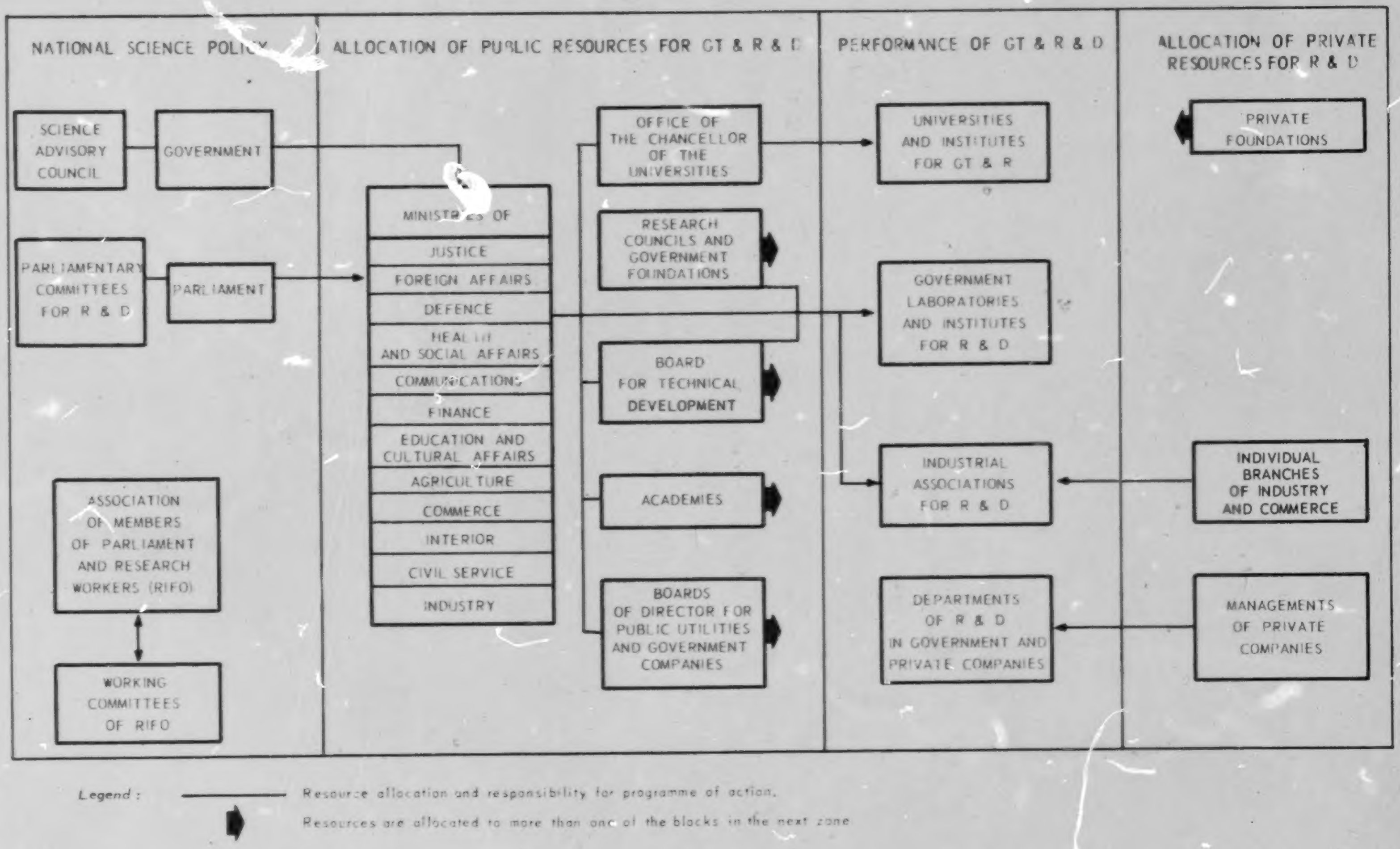
In the next section we present quite a general description of the organization of graduate training and research in Sweden in terms of decision levels. Keeping in line with the scope of this report we then confine the description to graduate training and research in the divisions of a University of Technology. This description will be found in section 3. In section 4 we make a preliminary analysis from the point of view of the programme budget theory of organization.

### 2. A NATIONAL OVERVIEW OF THE ORGANIZATION

In the following text we refer to Figure 3.1 which is a chart of the Swedish organization of graduate training and research. There are three main levels of decision :

Figure 3.1

ORGANIZATIONAL CHART OF GRADUATE TRAINING, RESEARCH AND DEVELOPMENT IN SWEDEN


NATIONAL SCIENCE POLICY
ALLOCATION OF PUBLIC RESOURCES FOR GT & R & D
PERFORMANCE OF GT & R & D
ALLOCATION OF PRIVATE RESOURCES FOR R & D
SCIENCE ADVISORY COUNCIL
GOVERNMENT
PARLIAMENTARY COMMITTEES FOR R & D
PARLIAMENT
ASSOCIATION OF MEMBERS OF PARLIAMENT AND RESEARCH WORKERS (RIFO)
WORKING COMMITTEES OF RIFO
MINISTRIES OF
JUSTICE
FOREIGN AFFAIRS
DEFENCE
HEALTH AND SOCIAL AFFAIRS
COMMUNICATIONS
FINANCE
EDUCATION AND CULTURAL AFFAIRS
AGRICULTURE
COMMERCE
INTERIOR
CIVIL SERVICE
INDUSTRY
OFFICE OF THE CHANCELLOR OF THE UNIVERSITIES
RESEARCH COUNCILS AND GOVERNMENT FOUNDATIONS
BOARD FOR TECHNICAL DEVELOPMENT
ACADEMIES
BOARDS OF DIRECTOR FOR PUBLIC UTILITIES AND GOVERNMENT COMPANIES
UNIVERSITIES AND INSTITUTES FOR GT & R
GOVERNMENT LABORATORIES AND INSTITUTES FOR R & D
INDUSTRIAL ASSOCIATIONS FOR R & D
DEPARTMENTS OF R & D IN GOVERNMENT AND PRIVATE COMPANIES
PRIVATE FOUNDATIONS
INDIVIDUAL BRANCHES OF INDUSTRY AND COMMERCE
MANAGEMENTS OF PRIVATE COMPANIES
Legend :
Resource allocation and responsibility for programme of action.
Resources are allocated to more than one of the blocks in the next zone

1. The formulation of national science policy;
2. The allocation of resources for GT&R&D;
3. The programme level at which GT&R&D is performed.

Of course there is an obvious overlap in this division. The formulation of science policy means giving general goals for research work. The instrument of control is the process of allocating resources for realizing the objectives.

## The National Science Policy

Parliament makes the most important decisions concerning the national science policy. By granting resources for graduate training and research and by formulating rules for their use, Parliament controls that the main goals of the national science policy are fulfilled. Special committees prepare most of the issues before Parliament makes the formal decisions. The most important committee is the Standing Committee of Supply.

The most important research questions that Parliament has to deal with concern :

1. Resource grants;
2. Rules for allocating the resources;
3. Changes in the R&D-organization. The establishment of new agencies and scientific institutions. Administrative rules.

In order to create more organized contacts between active scientists and Members of Parliament, the Association of Members of Parliament and Research Workers (RIFO) was formed in 1959. By discussing science policy questions, by arranging hearings with members of the Government, officials of the ministries, etc., RIFO forms a basis for parliamentary decisions.

Government is responsible for the execution of the parliamentary decisions. The Government is divided into a dozen different ministries each representing a special sphere of interest. These ministries are small organizational units dealing mainly with policies and planning.

The Science Advisory Council (established in 1962) constitutes a link between the Government officials and the research workers. Discussions take place in the council but the body does not execute any formal control of research and development.

## Allocation of Resources

National science policy is determined during the budget debate on state expenses. Each ministry is responsible for activities within its sphere of interest and is supposed to present a budget request to the Ministry of Finance. These bills are then linked together to form a complete Government Budget Proposal presented to Parliament in January every year. The proposal covers the fiscal year July to the following June. Parliament passes the Budget Proposal and the bills go back to the ministries which are responsible for the execution of the parliamentary decisions, including the allocation of resources to the government agencies.

The ministries also present to Parliament programmes of activities for their sphere of interest. After Parliament has granted the funds the ministries are supposed to give detailed rules to the agencies on how to use the resources in accordance with the goals formulated in the programme. These rules are collected in the Royal Regulation Letter presented to the government agencies during the spring term. This letter is worked out in cooperation with the agencies.

There is no special ministry devoted to research questions. Instead research issues are divided between the ministries with respect to scientific fields. How the responsibility for GT&R is shared by the ministries is roughly indicated in Table 3.1.

There are also other ministries involved in research policy. For instance, the Ministry of Health and Social Affairs is responsible for part of the medical research, and the Ministry of Social Welfare partly conducts social science research. We shall not give any detailed comments at this point on this organizational structure. There is, however, reason to make the following statements :

- The allocation of resources to university decisions from more than one agency makes the control of activities and output with reference to the goals a very complicated process. From the point of view of programme budgeting each subsidy must be connected with an operational goal and a plan comprising staff, space, and equipment requirement in order to make it possible for the individual and the university to keep a certain control over the total resources and the results expected thereof.
- Certain fields of research are not defined by any of the established research councils and funds. The research workers often have to reformulate their goals in order to get their applications accepted by the councils. This means that new fields of research run the risk of not being supported to the extent motivated by their importance.

From the ministries we turn to the agencies that actually handle the planning for GT&R activities. Since these agencies are of prime interest to

Table 3.1

BREAKDOWN OF RESPONSIBILITY FOR GT & R AMONG MINISTRIES

| Ministry of | Field of responsibility | Executive agency |
|---|---|---|
| Education and Cultural Affairs | Education in the university sector | Office of the Chancellor of the Universities (OCU) |
| | Human sciences | Humanities Research Council |
| | Social sciences | Council for Social Science Research |
| | Medical sciences | Medical Research Council (MRC) |
| | Nuclear sciences | Atomic Research Council (ARC) |
| | Natural sciences | Natural Science Research Council (NRC) |
| Industry | Technology, Industrial Development | Board for Technical Development (BTD)<br>Iron Ore Foundation for Scientific and Industrial Development<br>Norrland Foundation |
| Interior | Construction and Building | Council for Building Research (BRC) |
| Agriculture | Education in the field of Agriculture and Forestry.<br>Agriculture<br>Forestry<br>Co-ordination of environmental problems | Forest and Agriculture Research Council |
| Communications | Transportation<br>Traffic Safety<br>Telecommunication | Council for Traffic Safety Research |
| Finance | General support of research and development | The Bank of Sweden Tercentenary Fund |

individual scientists and teachers a more detailed description of their organization seems appropriate.

## The Office of the Chancellor of the Universities (OCU)

Government instructions impose a number of tasks on OCU, namely to :

1. Follow the development of conditions and needs of research and higher education and to undertake necessary measures in order to improve organization and objectives according to the demands of society;
2. Lead the planning of higher education;
3. Be concerned about the development of costs and to see that resources for research, education and management are efficiently exploited;
4. Support the activities of the universities and circulate information about higher education and research among people affected by the activities;
5. Produce budget requests concerning the universities once a year.

Thus OCU is responsible for the basic resources of the universities, staff for higher education and research, equipment, computer time and other current expenses. The following fields of knowledge are included in the programme :

- Natural Sciences
- Technology
- Humanities
- Social Sciences
- Medicine

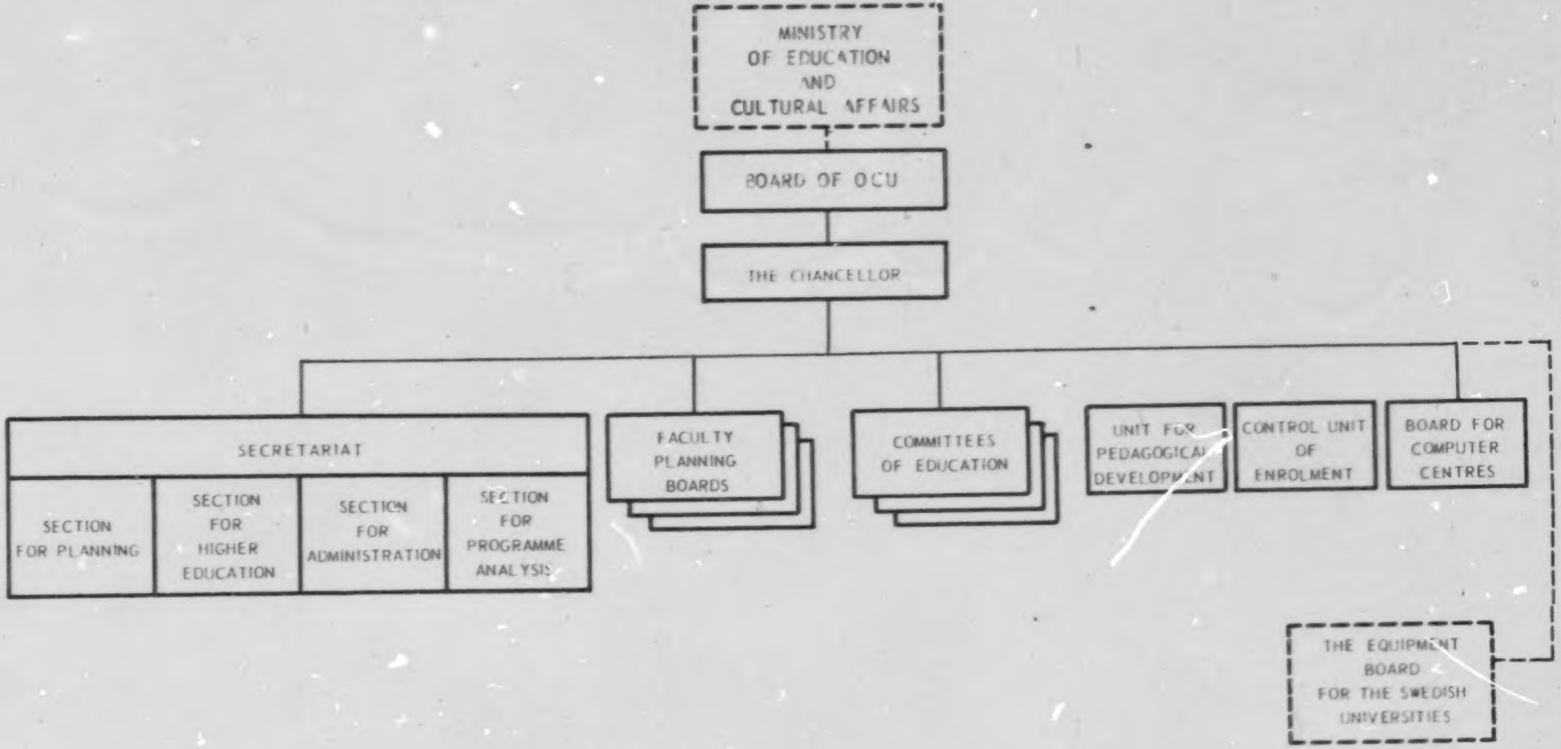
Each field comprises a number of faculties located at different universities.

The organization chart is given in Figure 3.2 The overview of the organizational and economic development is handled by the secretariat which is divided into four sections (planning, education, administration and programme analysis). For each of the fields above there is a Faculty Planning Board which serves as an advisory body for planning the expansion of the faculties. The main questions to be handled by the Faculty Boards are :

1. The allocation of financial resources to the faculties connected to the field in question.
2. The establishment of new higher offices at the universities (professorships, lecturerships).

Figure 3.2

ORGANIZATION CHART FOR THE OFFICE OF THE CHANCELLOR OF THE UNIVERSITIES (OCU)


MINISTRY OF EDUCATION AND CULTURAL AFFAIRS
BOARD OF OCU
THE CHANCELLOR
SECRETARIAT
SECTION FOR PLANNING
SECTION FOR HIGHER EDUCATION
SECTION FOR ADMINISTRATION
SECTION FOR PROGRAMME ANALYSIS
FACULTY PLANNING BOARDS
COMMITTEES OF EDUCATION
UNIT FOR PEDAGOGICAL DEVELOPMENT
CONTROL UNIT OF ENROLMENT
BOARD FOR COMPUTER CENTRES
THE EQUIPMENT BOARD FOR THE SWEDISH UNIVERSITIES

3. Re-organization of higher education and research institutions.

For the purpose of controlling the curricula of the different schools subordinated to OCU there are a number of Committees of Education. The members represent private and public institutions interested in the outcome of education in their particular field of interest.

The units for pedagogical development and enrolment are service units for undergraduate education.

The Board of the Computer Centres is responsible for the management of the computers for education and research in different universities in Sweden. However, the control of investments of new computer equipment is executed by the National Foundation for Computers. This foundation is managed by the National Office of Organization and Management.

It should be mentioned in this connection that money for computer time is granted to OCU through a special Government proposition. The Board for Computer Centres allocates this grant to the universities on the basis of available capacity. The Board also controls the use of the computers by internal pricing.

## The Organisation of Building and Equipment Investments for the Swedish Universities

These activities do not fall under the Office of the Chancellor although the organizations have many problems in common, e.g. the dimensioning of education and research and the problem of allocating resources. In 1964 when the Office of the Chancellor was re-organized it was considered too complicated to merge the organizations. One reason might be the somewhat complicated structure of the organization for buildings and equipment.

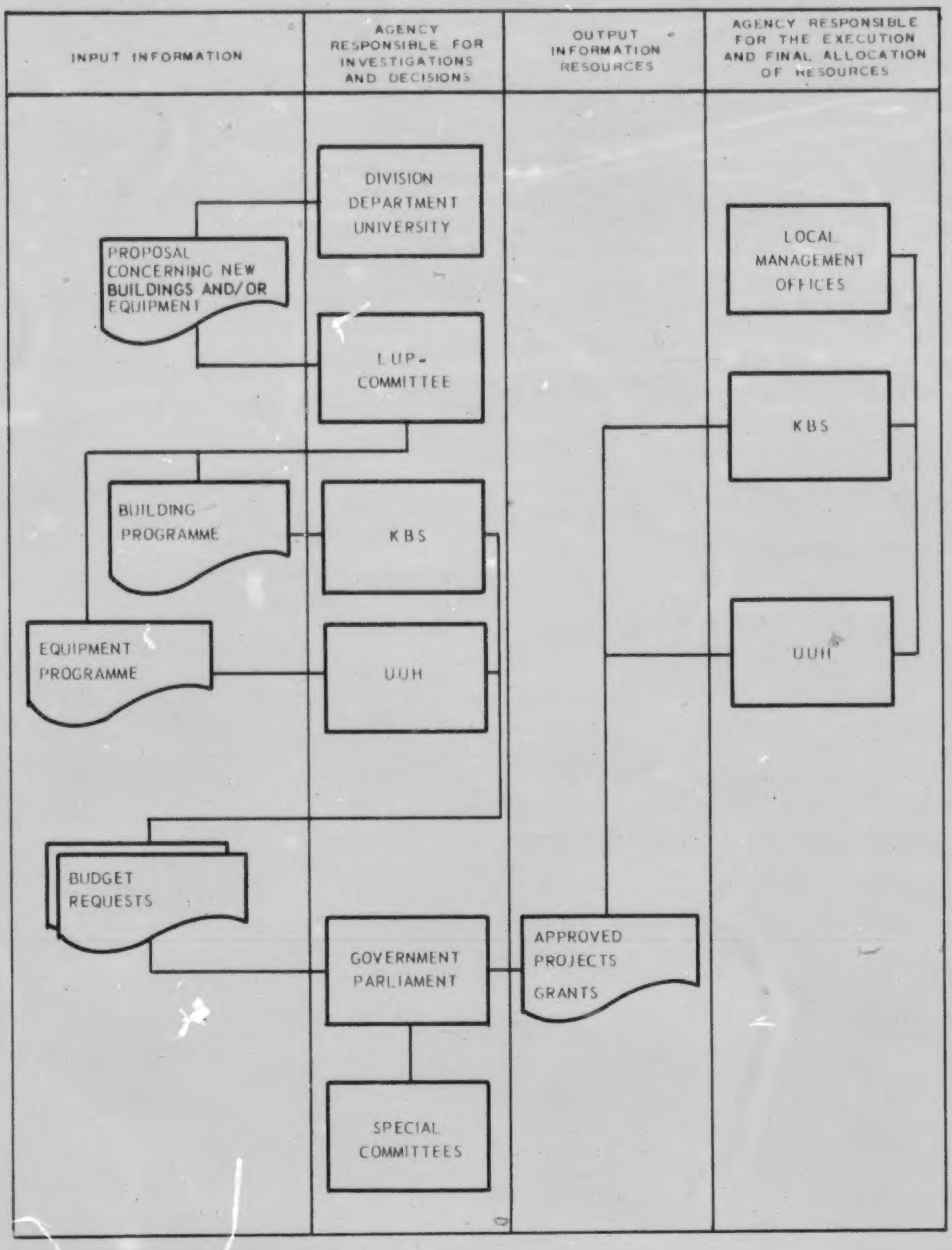
The following description of how a building or equipment issue is treated by the different agencies can be followed in Figure 3.3 which shows a chart of decisions. A proposal concerning a new building, new expensive equipment (which normally cannot be written off at once) or the need for rebuilding, is usually raised by the university. The arguments for the new building or the new equipment are presented in a programme and sent to The Local Planning Committee of Building and Equipment for the Swedish Universities (the LUP-Committee). The Committee is supposed to decide how important a project is with relation to the needs of higher education and research. The committee has no economic responsibility for the decisions and therefore the attitude toward the applications is normally positive.

If the LUP-committee approves of a project the programme goes to

1. The National Board of Building and Planning (KBS) in the case of building projects.

Figure 3.3

THE PROCESS OF GRANTING RESOURCES FOR BUILDING AND EQUIPMENT


INPUT INFORMATION
AGENCY RESPONSIBLE FOR INVESTIGATIONS AND DECISIONS
OUTPUT INFORMATION RESOURCES
AGENCY RESPONSIBLE FOR THE EXECUTION AND FINAL ALLOCATION OF RESOURCES
DIVISION DEPARTMENT UNIVERSITY
PROPOSAL CONCERNING NEW BUILDINGS AND/OR EQUIPMENT
LUP-COMMITTEE
BUILDING PROGRAMME
KBS
EQUIPMENT PROGRAMME
UUH
BUDGET REQUESTS
GOVERNMENT PARLIAMENT
SPECIAL COMMITTEES
APPROVED PROJECTS GRANTS
LOCAL MANAGEMENT OFFICES
KBS
UUH

2. The Equipment Board for the Swedish Universities (UUH) in the case of an equipment project.

These agencies in the first place make their own investigations concerning the possibility of solving the problem by using available buildings or equipment. If this is not possible a request is sent to the Government. The Ministry concerned by the project usually appoints a special Committee with the objective of investigating the proposed project.

If Government and Parliament approve a project, Parliament in the Government Budget Proposals grants a maximum amount of money to be spent on the project and also determines the time when the project is to be finished. If the original budget plan for the project does not hold, Parliament adjusts the appropriation in the next Government Budget Proposal. The appropriations are disposed of by KBS or UUH depending on the nature of the budget. These Boards are also responsible for the planning and actual performance of the projects.

From what has been said above concerning the organization for building and equipment we conclude that :

1. The LUP-Committee is responsible for judgements concerning the actual need for improvements from the point of view of higher education and research.
2. The KBS and UUH boards make up the detailed plans and receive the grants for executing the projects.
3. Government makes special investigations concerning especially "complicated" (from the political point of view) projects.
4. Parliament grants resources for fulfilling the projects and also makes the final decisions regarding which projects are to be performed.

It should be pointed out that there are no formal links between this organization and the agencies responsible for grants to education and research at the Swedish universities. This appears to be an important failure of the system. We will return to this problem later in the report.

## The Research Councils

In this group of agencies we also include the Board for Technical Development (BTD). All of the councils and foundations that grant money to the technical institutes are mentioned in Table 3.2 At present there is a total of ten research councils (including BTD) and three government foundations but the number changes often since the creation of these allocating agencies is an important instrument for the Government to fulfil national policy.

There are two main objectives that seem to be common to the councils :

1. Providing grants to individual research workers, research groups or institutions.
2. Promoting new research projects related to an expected development of the future of science.

The councils to be treated are listed below.

Table 3.2

| Research councils | Abbr. | Total grants to R&D 1969/70 (1000 Sw. Kr.) | Total grants to CTH 1969/70 (1000 Sw. Kr.) | Percentage of total grants from research councils to CTH |
|---|---|---|---|---|
| The Swedish Atomic Research Council | ARC | 13,758 | 2,136 | 18.7 |
| The Swedish Natural Science Research Council | NRC | 35,536 | 1,666 | 14.6 |
| The National Council for Building Research | BRC | 40,416 | 1,942 | 17.0 |
| Board for Technical Development | BTD | 64,025 | 4,272 | 37.5 |
| Grants from other research councils | | | 372 | 12.2 |
| Total grants from research councils to CTH 1969/70 | | | 11,388 | 100.0 |

The Swedish Atomic Research Council (ARC) 1970/71 received government grants for the following three purposes :

1. Nuclear research in Sweden;
2. Participation in the European Organization for Nuclear Research (CERN);
3. Co-operation with the Nordic Institute for Theoretical Physics (NORDITA).

Grants for research applications are proposed by three delegations : Delegation for Physics, for Chemistry and for Biology. There is also a special committee working with grants to CERN.

Further, ARC regularly appoints special committees for the purpose of investigating research going on within certain fields of interest. Two immediate examples are the committees for radiation measurements and accelerator questions.

The Swedish Natural Science Research Council (NRC) has an organization similar to ARC. The four delegations are completely responsible for the proposals of grants to specific research projects : Delegation for Physics and Mathematics, for Chemistry, for Geosciences and for Biology.

In addition, NRC has organized a number of special committees representing specific operations that NRC is responsible for. The objectives for these committees are listed below :

European Southern Observatory (ESO)
Intergovernmental Oceanographic Commission (IOC)
International Hydrological Decade (IHD)
Information Research
Ecology
Biophysics.

ARC and NRC co-operate in many respects and together finance some of the special committees (i.e. the Committee on Research Economics) and services (i.e. the publication "Research and Progress").

The prime function of the delegations is to propose grants to applications.All of the grants proposed by the delegations pass the Working Committee of the council in question. Small grants, less than 25,000 Sw. Kr. are in practice decided on by the Working Committee. However, all grants have to be formally passed by the Council. When one individual grant exceeds 300,000 Sw. Kr., the Government is to sanction the grant. This latter rule holds for all research grants in Sweden.

Through the special committees the councils initiate, make up plans for, and control research within new or not-yet defined areas of research. In this way the second main objective of the research councils is fulfilled. It should be pointed out that the members of the Council, and the committees represent a considerable knowledge of scientific research in Sweden. This knowledge serves as an important basis for decisions in NRC and ARC, and make these institutions adequate for overseeing and disposing of the Swedish research potential within the fields of natural science and nuclear physics.

The National Council for Building Research (BFC) is different from the other research councils regarding the economic basis for activities. While the other research councils receive resources through direct state grants, BRC disposes of a foundation, the Building Research Foundation, whose financing comes from a tax on all salaries. The tax is 0.6 per cent of the total amount of salaries.

The following objectives are found in the rules of the BRC :

1. To collect information regarding the need for research and rationalization within the field of building;
2. To see to it that research and rationalization aim at improving especially important functions;
3. To grant subsidies to institutions and individuals for research and experimental activities within the field of building;
4. To control that the subsidies granted are used for the research originally intended;
5. To spread information about the results arrived at in the projects financed by the Council.

The activities of BRC are divided into five main programmes :

1. Community and Building Planning;
2. Materials and Constructions;
3. Installations;
4. Production and Administration;
5. Information and General Activities.

Each programme corresponds to a section of the secretariat. Like the other research councils BRC continually appoints committees that are to investigate the need for research and formulate research programmes for specific fields.

The Swedish Board for Technical Development (BTD) was established in 1968. According to the Government rules BTD is the central administrative body for initiatives, support, planning and consultation within the field of technical research and industrial development. More precisely the activities are defined by four programmes (1) :

Programme 1 : Financial support to technical research and development.

Sub-programmes :

1.1 Fundamental technical research
1.2 Applied technique

---

(1) BTD is like the Office of the Chancellor;it is covered by a pilot study on programme budgeting.

1.3 Information and documentation
1.4 International contacts.

Programme 2 : Investigation and Planning

Programme 3 : Consultation and Mediation

Sub-programmes :

3.1 General activities supporting innovations
Creativity research
3.2 Advisory service and support to inventors
Support to the exploitation of inventions
3.3 Contact activities between industry and universities, institutes, research institutions, etc.

Programme 4 : Management of the research stations.

We recognize three important parts of the organization :

The Board - responsible for policy and management of STD.
The Secretariat - handles the current activities, planning, economic questions, analysis of applications, advisory service, etc.
The Committees - each committee is responsible for a certain technical field. Within the framework fixed by the Board, the committees are supposed to initiate and support research in the field in question. However, there are a number of committees that may decide on subsidies without consulting the Board.

The Board makes a total division of the grants to specifically defined fields of technology. In the case of the corresponding committee deciding on grants, two-thirds of the financial framework is made available for decision in the committee. The rest, one-third, is disposed of by the Committee for General Technical Research Questions. This committee is responsible for all grants that cannot be decided on by the other committees. There are further a number of technical fields for which the committees only propose grants. These grants are sanctioned by the "General Committee".

Each committee divides the applications into two priority groups :

1. Subsidy is granted within the framework for the technical field in question.
2. The application will be treated at the next meeting. Eventually the application is transferred to the "General Committee" for decision.

The priority system described is used for the sub-programmes 1.1 and 1.2 (fundamental and applied research). The financial aid is used in three different ways :

a) Technical research to research divisions. This aid corresponds to the grants from the ordinary research councils.
b) Collective research. This kind of research is initiated through co-operation between BTD and industries within a certain branch.
c) Technical development. Financial aid or loans are granted to individual industries.

## Government Foundations

In addition to the research councils there are a number of Government foundations which operate on roughly the same principles. The most important ones are :

The Bank of Sweden Tercentenary Fund - established in 1965 to support mainly social science research.
The Swedish Iron Ore Foundation for Scientific and Industrial Development.
The Norrland Foundation.

The Iron Ore Foundation is now incorporated in the Board for Technical Development, while the Norrland Foundation is an entirely independent body.

## Academies

The scientific academies are primarily concerned with the environmental aspects of research and development, for instance, contacts between the scientists, conditions for creative work. Special investigations of new scientific fields are often initiated by the academies in order to trace the future of scientific and technical development.

There are three academies concerned with scientific work : The Royal Academy of Science, The Royal Academy of Engineering (IVA) and The Royal Academy of Agriculture and Forestry.

## Development Companies

In the private sector a number of commercial banks have set up development companies. Their function is, by the acquisition of business enterprises and other measures, to merge companies which are considered to have a growth potential, and to actively promote the utilization of research results, innovations and valuable inventions.

## The Performance of GT&R at the University Level

Figure 3.1 shows that many different types of institutions are involved in the actual performance of research and graduate training as well as development work. However, it has hitherto been attempted to concentrate graduate training and fundamental research in universities and higher educational establishments (institutes). When research work is of such magnitude or special character that it cannot be incorporated within the university organization, or when it includes a considerable amount of routine testing, etc., special institutes are established, which are very often co-ordinated with the universities and higher educational establishments.

The Government law for the universities comprises rules for the organization of the universities. Each university is constituted by its teachers and the registered students. Each university comprises one or more faculties which may be divided into departments. The primary unit of production is the division. Normally a division has at least one professor, an office for which there is always a professor's programme defining the guidelines of the research to be performed at the division.

For joint services there is a central administration unit and a number of auxiliary units such as library, management of building and campus area. The Rector is the head of the university and president of the Board of the University. According to the university law the Board is supposed to overview and control educational and scientific activities going on at the university. Economic and administrative issues are to be treated by the Board of University.

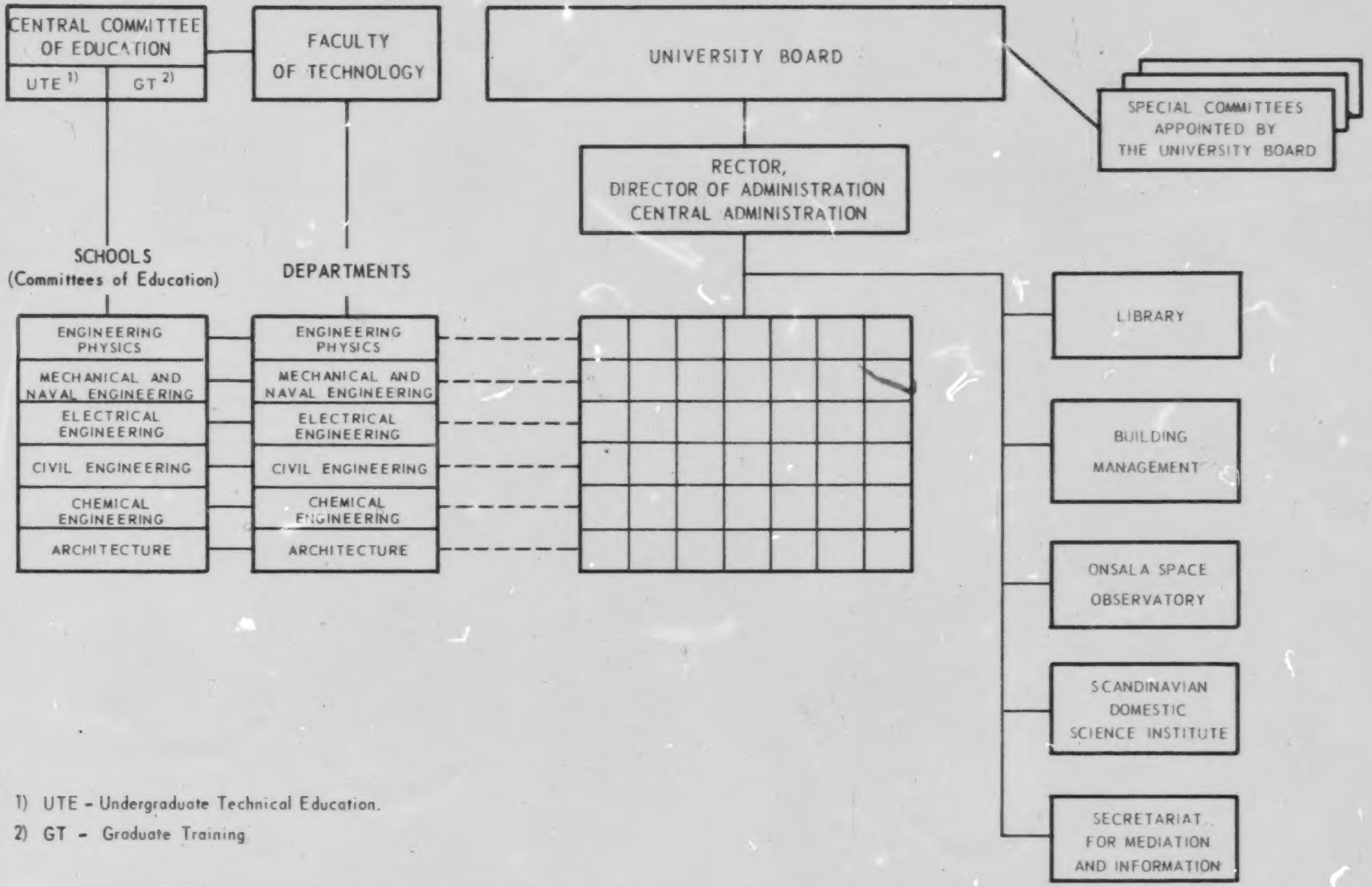
Before we go on describing the university organization a glance at the organization of Chalmers University of Technology (CTH) would seem pertinent. The concepts "department" and "school" should be clearly distinguished. Thus the department is the producing unit and the school is the consumer of education.

The University Board and the department control the scientific, economic and administrative activities. Within each department the control function is executed by a board comprising all of the permanent teachers and scientists of the department. The Dean is president of the board and head of the department. The most important instrument of control available to these executive bodies are :

1. The Budget Request. Each department in year 0 makes a Proposal concerning year 2 which is sent directly to the Office of the Chancellor. The University Board makes a Proposal for the central and auxiliary bodies. It also comments on the Department Proposals by suggesting priorities and by giving an overall view of the

Figure 3.4

THE ORGANIZATION OF CHALMERS UNIVERSITY OF TECHNOLOGY


CENTRAL COMMITTEE OF EDUCATION
UTE 1)
GT 2)
FACULTY OF TECHNOLOGY
UNIVERSITY BOARD
SPECIAL COMMITTEES APPOINTED BY THE UNIVERSITY BOARD
RECTOR, DIRECTOR OF ADMINISTRATION CENTRAL ADMINISTRATION
SCHOOLS (Committees of Education)
DEPARTMENTS
ENGINEERING PHYSICS
MECHANICAL AND NAVAL ENGINEERING
ELECTRICAL ENGINEERING
CIVIL ENGINEERING
CHEMICAL ENGINEERING
ARCHITECTURE
ENGINEERING PHYSICS
MECHANICAL AND NAVAL ENGINEERING
ELECTRICAL ENGINEERING
CIVIL ENGINEERING
CHEMICAL ENGINEERING
ARCHITECTURE
LIBRARY
BUILDING MANAGEMENT
ONSALA SPACE OBSERVATORY
SCANDINAVIAN DOMESTIC SCIENCE INSTITUTE
SECRETARIAT FOR MEDIATION AND INFORMATION

1) UTE - Undergraduate Technical Education.

2) GT - Graduate Training

activities of the University. In connection with programme budgeting work the Proposal of the University Board, the Programme Budget Proposal, has become the most important document.

2. Allotment of the Programme Grant. From the fiscal year 1971/72 and on, Chalmers University of Technology receives a Programme Grant covering expenses for activities within its Higher Education and Research programme. At present the University Board is supposed to allot these resources to the departments which make the final allotment to the divisions. It should be noted that there is so far a small degree of freedom since more than 80 per cent of the resources constitute salaries and permanent costs which the University Board may allocate according to internally decided principles.
3. Appointments. Table 3.3 lists the offices available for teachers and scientists. The offices constitute an important instrument of control since each office has a certain obligation to take part in teaching. An extended freedom is given to the university as programme budgeting develops. Thus the university may establish extra lecturer offices.

As was mentioned the University Board is also responsible for the scientific activities at the university. However, we recognize that this task can be fulfilled to a very low degree. We shall make two important considerations :

1. Originally research was looked upon as a by-product of higher education. As higher education expanded during the 50's and 60's research and development at the universities expanded as well.
2. Most of the research projects at CTH are to some extent supported by the research councils or the foundations. Therefore the university does not represent the consumer of research like the Committees of Education represent the consumers of education. Thus the University Board allots financial resources for research activities to the divisions without being in the position to control the output, effectiveness, etc., of the research programme. The organization is obviously not quite adapted to the claims of a functioning programme budget system. This problem will be further analysed in the conclusions (section 4).

Table 3.3

## OFFICES FOR TEACHERS AND SCIENTISTS

| Office | Teaching obligations | Time of appointment (years) | Average salary 1000 Sw. Cr./year | Authority responsible for establishing the office | Authority responsible for appointments |
|---|---|---|---|---|---|
| Professor | 132 hours/year | | 78.4 | Government | Government |
| Associate Prof. | 132 hours/year | | 71.0 | " | " |
| Assistant Prof. | 75 hours/year Supervision of at most 6 grad graduate stud. | 2x3 (2) | 54.3 | Government (1) | Board of University |
| Research Asst.(3) | 198 hours/year Supervision of at most 9 graduate stud. | 2x3 | 46.4 | Government (1) | Board of University |
| Lecturer | 396 hours/year | | 71.0 | Government | Board of University |
| Asst. Lecturer | 1000 hours/year (4) | 4x1 (5) | 32.9-40.0 | Board of University (6) | Board of University |
| 1. Assistant (7) | 500 hours/year | 4x1 (5) | 16.4-20.0 | " | " |
| 2. Assistant (7) | 300 hours/year | 4x1 (5) | 11.0 | " | " |
| 3. Assistant (7) | 225 hours/year | 4x1 (5) | 8.2 | " | " |

1) Government sets faculty while the University Board sets department for the Office.

2) Each assistant professor and research assistant is appointed for 3 years but is usually re-appointed to another 3 years. Further the appointment may finally be prolonged by one year.

3) There are research assistants appointed by the research councils which are not included in this concept.

4) Total time of work for the division.

5) An assistant is automatically re-appointed 3 times. After four years of appointment special considerations have to be made before the assistant may be re-appointed for another year.

6) The Office of the Chancellor decides how many assistant hours are to be allocated to each university. The Board of University may establish office of assistant within this limit.

7) These offices are not established at CTH.

# 3. GOALS AND ORGANIZATION OF A DIVISION AT CHALMERS UNIVERSITY OF TECHNOLOGY

As the primary unit of production the division is in many respects an autonomous administrative unit. The staff, except for those employed by the central administration and service functions, is always referred to divisions. The financial resources are finally allotted to the individual divisions or to projects within the range of the scientific programme of the division. The divisions dispose of most of the available space of the university.

There are four main groups of activities that take place in a division :

1. Undergraduate education
2. Graduate training
3. Research
4. Service functions - administration, workshop, library, etc.

For the output-oriented programmes of undergraduate education, graduate training and research, there are goals set by central authorities. However, the division is to a great extent free to dispose of the resources in order to fulfil the goals. Obviously the efficiency of a single division is an important parameter determining the output of the university as a whole. Thus there are good reasons for making a more detailed analysis of the organization and goals of a division. This analysis constitutes the basis for an output-oriented programme budgeting system and the related information system.

With regard to input the division is controlled by a number of different agencies. The organization of these agencies was described in the preceding paragraph. Figure 3.5 illustrates how the agencies control the activities of the division through the allocation of different types of resources. We recognize that some kind of application or request precedes every allotment of resources. Thus the division is supposed to initiate the process by making up a programme for the activities and by applying for the necessary resources.

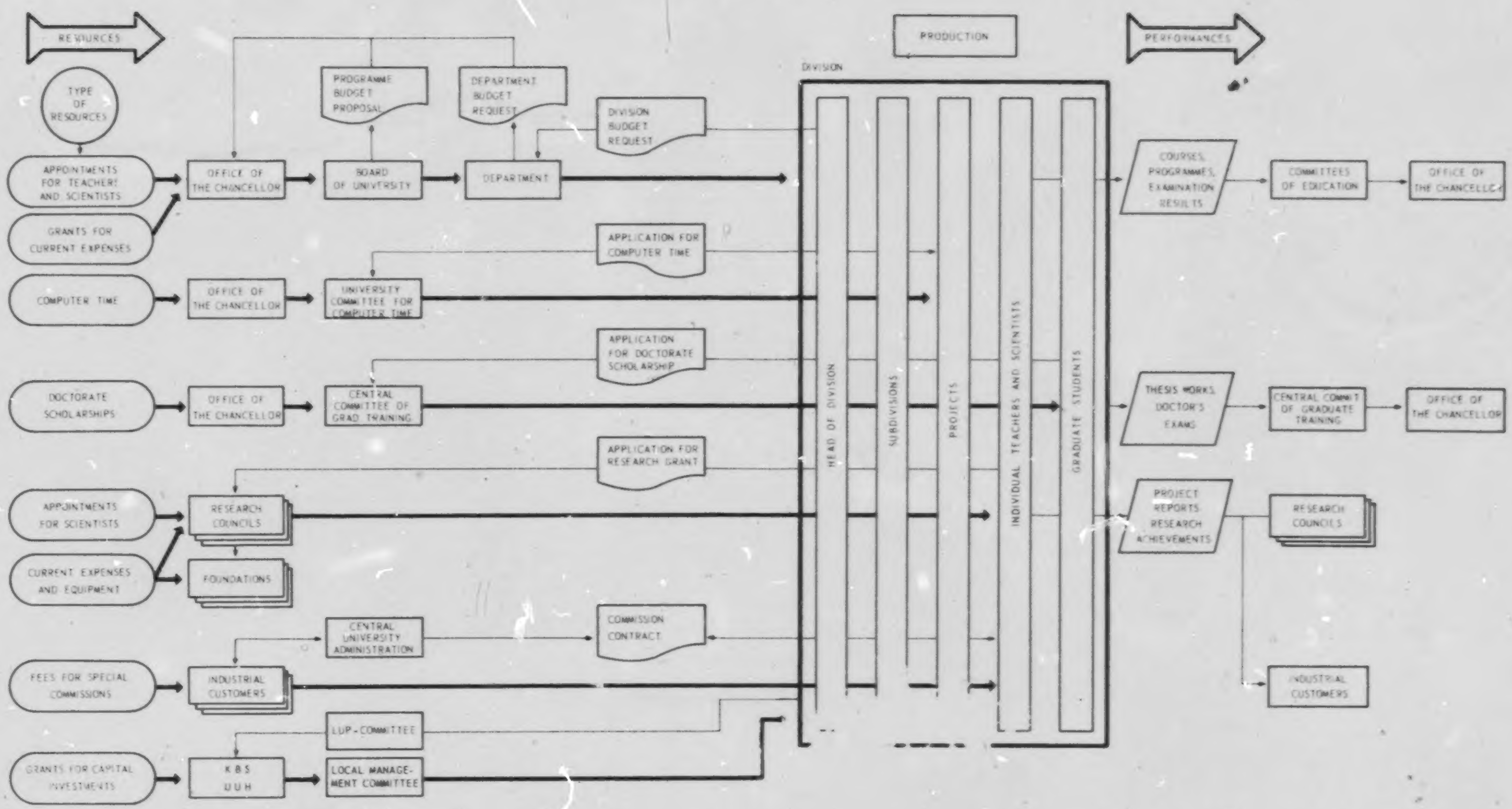
The basis for the divisional work is its goals. We distinguish between external goals and internal objectives. The former are formulated by the central agencies while the division itself works out the internal objectives.

## External Goals

The basis for the external goals are the assumptions concerning the future development of society. Together with political ideology these

Figure 3.5

INPUT AND OUTPUT OF A DIVISION


RESOURCES
TYPE OF RESOURCES
APPOINTMENTS FOR TEACHERS AND SCIENTISTS
GRANTS FOR CURRENT EXPENSES
COMPUTER TIME
DOCTORATE SCHOLARSHIPS
APPOINTMENTS FOR SCIENTISTS
CURRENT EXPENSES AND EQUIPMENT
FEES FOR SPECIAL COMMISSIONS
GRANTS FOR CAPITAL INVESTMENTS
OFFICE OF THE CHANCELLOR
BOARD OF UNIVERSITY
DEPARTMENT
PROGRAMME BUDGET PROPOSAL
DEPARTMENT BUDGET REQUEST
DIVISION BUDGET REQUEST
OFFICE OF THE CHANCELLOR
UNIVERSITY COMMITTEE FOR COMPUTER TIME
APPLICATION FOR COMPUTER TIME
OFFICE OF THE CHANCELLOR
CENTRAL COMMITTEE OF GRAD TRAINING
APPLICATION FOR DOCTORATE SCHOLARSHIP
RESEARCH COUNCILS
FOUNDATIONS
APPLICATION FOR RESEARCH GRANT
CENTRAL UNIVERSITY ADMINISTRATION
COMMISSION CONTRACT
INDUSTRIAL CUSTOMERS
LUP-COMMITTEE
KBS UUH
LOCAL MANAGEMENT COMMITTEE
PRODUCTION
DIVISION
HEAD OF DIVISION
SUBDIVISIONS
PROJECTS
INDIVIDUAL TEACHERS AND SCIENTISTS
GRADUATE STUDENTS
PERFORMANCES
COURSES, PROGRAMMES, EXAMINATION RESULTS
COMMITTEES OF EDUCATION
OFFICE OF THE CHANCELLOR
THESIS WORKS, DOCTOR'S EXAMS
CENTRAL COMMIT OF GRADUATE TRAINING
OFFICE OF THE CHANCELLOR
PROJECT REPORTS RESEARCH ACHIEVEMENTS
RESEARCH COUNCILS
INDUSTRIAL CUSTOMERS

assumptions lead to parliamentary decisions concerning goals for education and research. Government then passes laws and regulations for the agencies and for the individual institutions. Each division is directly or indirectly affected by these regulations. The following analysis of the goals of the programme for undergraduate education, graduate education and research intends to show the connection between national goals and divisional work.

## Undergraduate education

For the purpose of complementing the government law for the universities (The University Law) there is a royal proclamation concerning higher education at the technical faculties, Royal Statute 1969:332. This proclamation sets the number of schools at each university of technology. For each school there shall be a curriculum which is to be confirmed by the Office of the Chancellor. The curriculum constitutes the basis for the individual courses which are requested through the School Committees of Education by the individual divisions.

The Royal Statute 1969:332 further states that each student of technology is supposed to conclude an examination thesis covering about three months of full-time work.

## Graduate training

According to the Government Proposition (1969:31) the goals of graduate training are to give the student :

1. Knowledge of and practical experience in the logical and organizational methods applied in research;
2. A rough knowledge of the research frontier of the field that the student has decided to penetrate;
3. Knowledge of and skill in writing a doctor's thesis of good quality. The thesis work should be performed independently and be of some importance to the field of research;
4. A rough knowledge of present problems within a somewhat broader field of current research.

In the Proposition graduate training is assumed to cover four years of full-time study. In the case of the graduate student's being employed as assistant by the division the graduate training is assumed to take five years. As soon as a graduate student is accepted by a division, an individual work programme for his graduate training should be made up. The programme covers courses to be taken (covering a total of two years of full-time study) and a description of the field in which the thesis work is to be performed.

The Committee for Graduate Training did not give any principles for determining the volume of graduate training. So far the number of graduate students follows available scholarships and appointments for assistant lecturers, lecturers, etc. In 1969 the Office of the Chancellor appointed a special committee which is supposed to follow up the new graduate training programme. One of the problems is to work out practical rules for confirming the number of graduate students and this makes it possible to relate the volume of graduate training to the observed needs for advanced scientists. Until such rules of control exist the graduate training programme is highly dependent upon the programmes of undergraduate training and research.

## Technical Research

The external goals for research result from :

1. General instructions for the universities. Thus the University Law states that the goals of the universities are to carry on research and education. When a professor's office is to be established or a new professor is to be appointed, the Faculty Board , after consulting the department in question, proposes a professor's programme which is to be confirmed by Government.
2. National research policy. The national research policy is a product of general considerations on the government level. The Government propositions give the goals and instructions for the agencies, which Parliament confirms, in connection with the appropriation of grants to the different agencies.

The division may use its extra facilities for special commissions initiated by industrial customers. The rules for these activities are determined by the Office of the Chancellor. The most important principle is that all costs should be covered by fees paid by the customer. The University Law, however, has an important restriction, namely that a teacher or scientist is not allowed to take special commissions of research or education unless it is completely clear that the University Board is in charge of the revenues and that the person taking the commission is responsible for the fulfilment of the commission contract.

## The Service Functions

The self-evident aim of these functions is to support the main activities of higher education and research. An important purpose of the administrative function is to check that financial resources allocated to the division are used appropriately. Certain requirements regarding the accounting of costs and performances are put up by the central administration of the university and by the Office of the Chancellor. Except for the administrative function no other function is compulsory, since for the other functions such as library, supply and workshop there are central functions at the university or department level covering these fields.

## Internal Objectives

The internal objectives can be summarized as follows : To create an innovative and effective environment in order to fulfil the external goals formulated for the different programmes of the division.

There are in fact very few parameters that the division can actually influence, since most of the staff is at present appointed by external authorities. The division is only free to appoint technical and administrative personnel for the service functions. An important factor, however, is the internal organization of a division (Figure 3.6).

Figure 3.6

A GENERAL ORGANIZATIONAL CHART OF A DIVISION

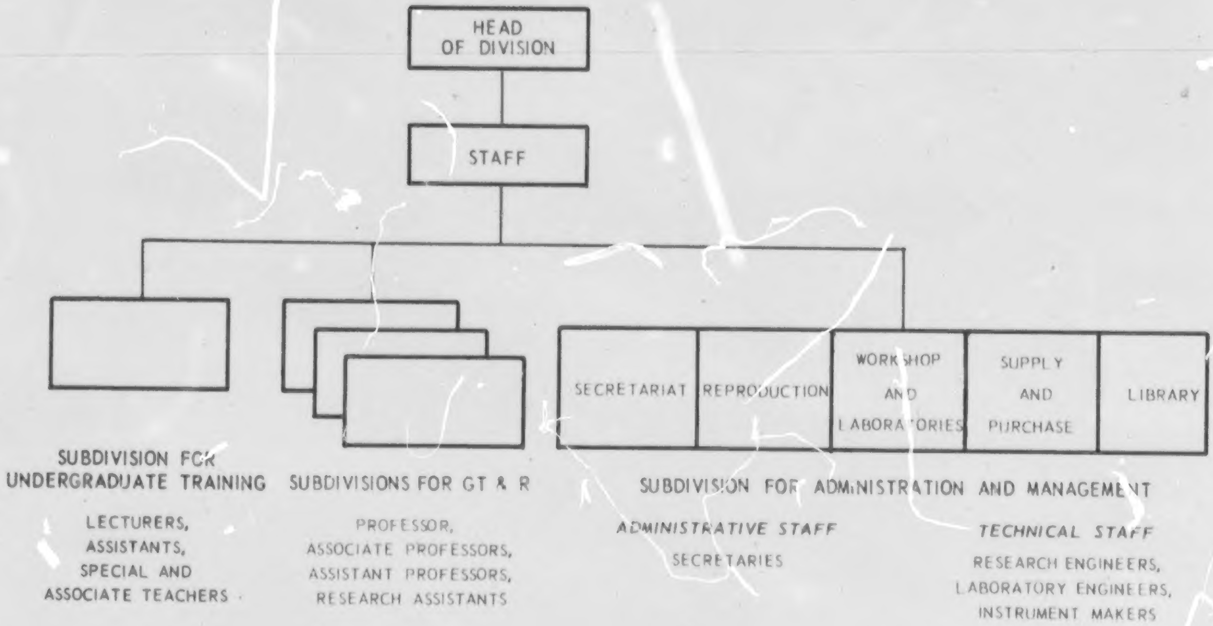

HEAD OF DIVISION
STAFF
SECRETARIAT
REPRODUCTION
WORKSHOP AND LABORATORIES
SUPPLY AND PURCHASE
LIBRARY
SUBDIVISION FOR UNDERGRADUATE TRAINING
LECTURERS, ASSISTANTS, SPECIAL AND ASSOCIATE TEACHERS
SUBDIVISIONS FOR GT & R
PROFESSOR, ASSOCIATE PROFESSORS, ASSISTANT PROFESSORS, RESEARCH ASSISTANTS
SUBDIVISION FOR ADMINISTRATION AND MANAGEMENT
ADMINISTRATIVE STAFF
SECRETARIES
TECHNICAL STAFF
RESEARCH ENGINEERS, LABORATORY ENGINEERS, INSTRUMENT MAKERS

Figure 3.6 shows one possible organization. Of course the internal organisation is primarily dependent upon the size of the division and the type of research going on (experimental or theoretical, laboratory or field research, council projects or special commissions, etc.). We point out that many of the teachers and scientists are tied to more than one subdivision. Thus the assistants in the undergraduate education subdivision are usually graduate students in some research subdivision.

One of the problems of managing a division is the treatment of conflicts between goals. Since the goals for the different programmes are set by different authorities without any co-ordination on the national level the division is subject to many separate claims which cannot all be fully satisfied. The goal conflicts emanate from the internal coupling at the university level between the main programme, undergraduate education, graduate education and research. This coupling does not correspond to a co-operation between the central agencies allocating resources to the different programmes. The organizational problems of linking the division and the university organization to the national research organization will be further analyzed in the following section.

## 4. CONCLUSIONS

The organization of GT&R in Sweden is considerably complex. In order to simplify the picture and to make the organization available for analysis we specify a number of subsystems which are to be analyzed from the point of view of programme budgeting theory.

### Analysis of the Organization for Higher Technical Education and Research

Figure 3.7 illustrates a general organization for controlling a production process. A central controlling unit sets objectives, grants resources and gives restrictions to a local controlling unit which is supposed to be in charge of the production. The objectives, that is more or less specified output claims, and the resources constitute the means of control of the central unit.

An important characteristic of the system is the existence of feed-back. Figure 3.7 illustrates two types of feed-back information from local to central units :

1. Reports from the customers or users concerning the value of the performances;

2. Reports from the local unit concerning the status of the process - performance related to the given objectives and to the available resources.

The central unit must have access to some external information including available strategies, general goals and qualified assumptions about the future in order to be able to exert a relevant control of the process.

In the following we try to analyze systems which can be identified with the general system of Figure 3.7. From the description in the preceding paragraphs we select six subsystems described in Table 3.4 and in Figure 3.8.

Figure 3.7

GENERAL MODEL FOR THE CONTROL OF PRODUCTION

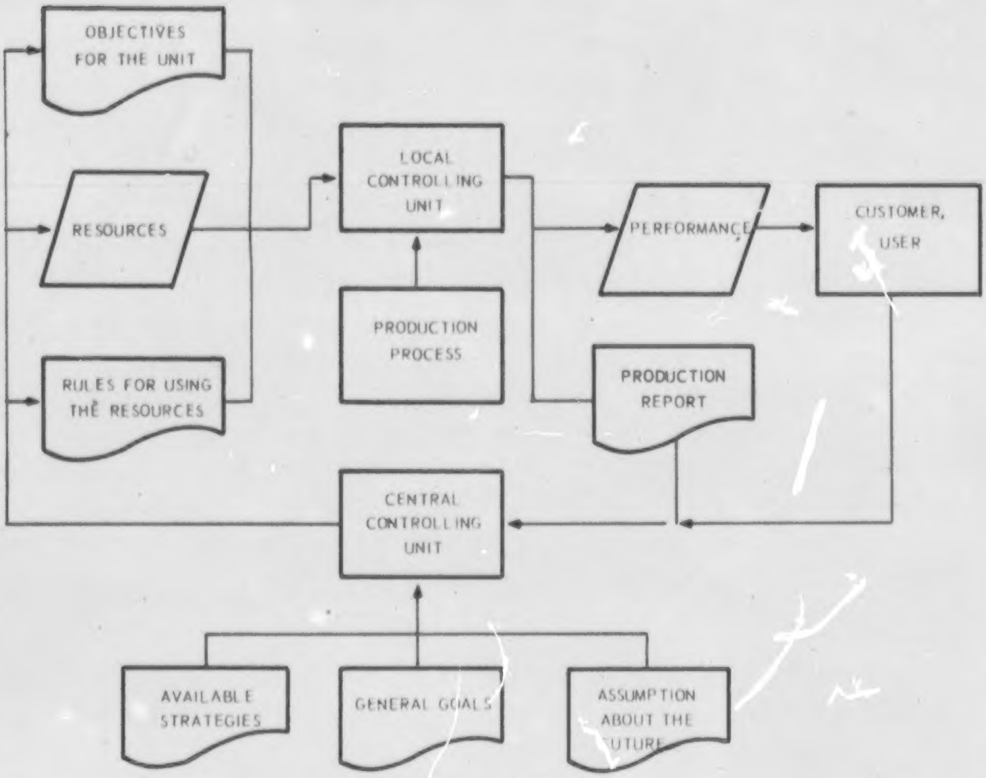
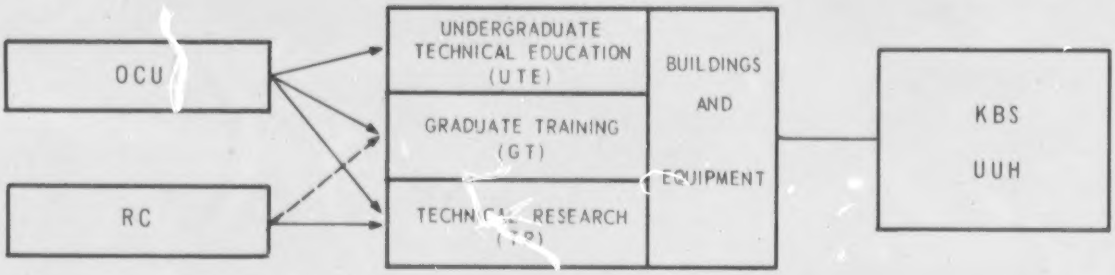

OBJECTIVES FOR THE UNIT
RESOURCES
RULES FOR USING THE RESOURCES
LOCAL CONTROLLING UNIT
PRODUCTION PROCESS
PERFORMANCE
CUSTOMER, USER
PRODUCTION REPORT
CENTRAL CONTROLLING UNIT
AVAILABLE STRATEGIES
GENERAL GOALS
ASSUMPTION ABOUT THE FUTURE

Table 3.4

| System Notation | Central Agency | Programme |
|---|---|---|
| OCU/UTE | Office of the Chancellor of Universities | Undergraduate Technical Education |
| OCU/GT | Office of the Chancellor of Universities | Graduate Training |
| OCU/TR | Office of the Chancellor of Universities | Technical Research |
| RC/GT | Research Councils | Graduate Research |
| RC/TR | Research Councils | Technical Research |
| KBS, UUH/ UTE, GT, TR | National Board of Building and Planning<br>Equipment Board for Swedish Universities | Building and Equipment for Higher Technical Education and Technical Research |

Figure 3.8

SUBSYSTEMS, CENTRAL AGENCIES/PROGRAMMES


OCU
RC
UNDERGRADUATE TECHNICAL EDUCATION (UTE)
GRADUATE TRAINING (GT)
TECHNICAL RESEARCH (TR)
BUILDINGS AND EQUIPMENT
KBS
UUH

In the first place we shall apply the five criteria, presented in Chapter 2, on the subsystems. In the analysis of the subsystem we further want to test two very important properties of a functioning programme budget organization :

A. The central controlling unit giving the objectives, resources and restrictions shall be responsible for the follow-up and control of the programme activities.

B. The measures undertaken by the central unit shall be based upon long-term planning. This corresponds to "Available strategies" and "Assumption about the future" in Figure 3.7.

A survey of our analysis is presented in Table 3.5. For each system there are two columns. One gives the primary facts supporting our judgement of the status of the subsystems with respect to the criterion in question. The second column is reserved for our judgements. We use the following notations :

| | |
|---|---|
| + | The subsystem perfectly meets the requirements of the criterion. |
| (+) | Part of the criterion is not satisfied by the subsystem. |
| - | The subsystem does not at all meet the requirements of the criterion. |

In the following we make some comments on the analysis of the subsystem and at the same time check how the subsystem complies with the requirements A and B above.

## OCU/UTE

This subsystem to a great extent fulfils the basic requirements. OCU is fully responsible for the undergraduate technical education and the goals and regulations are well defined in the University Law. OCU also exerts the control of the programme through reports on examination results, costs per student, etc.

A serious disadvantage of the system is that OCU is not in charge of means controlling buildings and equipment. This means that OCU cannot control long-term planning of capital investments. The same problem characterizes the system OCU/GT and OCU/TR. The (+) for criterion 3.2 points out the fact that it has not been possible to calculate total costs of the production of graduate engineers. We finally conclude that the subsystem well complies with criterion A and almost completely with requirement B.

Table 3.5

THE FIVE CRITERIA OF PPBS APPLIED TO THE PRESENT ORGANIZATIONAL UNIT AT THE NATIONAL LEVEL

| Criteria \ Subsystem | | OCU/UTE | | OCU/GT | | OCU/TR | | RC/GT | | RC/TR | | KBS, UUH/UTE, GT,TR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Responsibility and Goals for the programme | | The University Law | + | The University Law<br>The Graduate Training Prop (1969) | (+) | The University Law (No specific goals) | (+) | | | Government Propositions and instructions | + | Government Propositions and instructions | + |
| 2. Means of Control | 2.1 Output | Curricula<br>Enrolment | + | Curricula | (+) | Professor's Programme | (+) | | | Project plans<br>Long-term plans for special areas | + | Volume of buildings and equipment | + |
| | 2.2 Resources | Salaries (Current expenses (not investments) | (+) | Special grants to GT (teaching)<br>Scholarships | (+) | Offices<br>Appointments<br>Some current expenses | + | Appointments<br>Scholarships<br>Project grants | + | Project grants (short term) | (+) | Building and equipment grants | + |
| 3. Information from the programme part | 3.1 Planning | Budget requests | + | Budget requests | (+) | Budget requests (no information about output) | (+) | | | Project applications | (+) | Programmes for building | (+) |
| | 3.2 Feed-back | Examination Results<br>Labour-market reports | (+) | | - | | - | | | Project reports<br>Research catalogues | (+) | | - |
| 4. Expert decision-makers within the programme | | Committees of Education,<br>Secretariat Section for Higher Education | + | Special OCU-committee for GT | + | Faculty Planning Board (General knowledge of research problems) | - | | | Board of the Council | + | Expert only on building and equipment technology | - |
| 5. Representative decision-makers | | Faculty Planning Board | + | Faculty Planning Board | + | Faculty Planning Board (Broad representation) | - | | | Delegations Committees | + | | - |

Code :

| | | | |
|---|---|---|---|
| OCU | Office of the Chancellor of the Swedish Universities | UTE | Undergraduate Technical Education |
| RC | Research Councils | GT | Graduate Training |
| KBS/UUH | National Board of Building, Board of Equipment | TR | Technical Research |

+ The criterion is satisfied
(+) Part of the criterion is satisfied
- The criterion is not satisfied

OCU/GT

The resources for graduate training are scarce and therefore the granting of financial resources is not a satisfactory instrument of control.

There is little or no information about the programme passed on to OCU. Even at the university level very little is known about the individual performances within the graduate training programme. Regarding the Technical Faculties no qualitative or quantitative requirements related to the need for graduate training have so far been developed.

As for UTE, the Faculty Planning Board of Technology represents the most important decision-maker. There is one member from each faculty (Stockholm, Göteborg, Lund and Linköping) representing local interests. Further the Faculty Planning Board includes representatives of industry and of KBS as well as of the student organizations. There are good reasons for concluding that the Faculty Planning Board is a representative decision-maker as well as, in certain respects, an expert decision-maker.

The conclusion regarding OCU/GT is that requirement A is not fully met with since the follow-up is incomplete. Requirement B concerning long-term planning is not at all met with.

OCU/TR

The University Law only states a general responsibility of OCU regarding the programme TR. OCU is said to be responsible for the basic organization.No specific goals are given.

The means of control regarding the output are confined to the professor's programme which are confirmed by the Faculty Planning Board and which sets the primary aims of the research programme. However, OCU does not form any research policy or put any qualitative requirements on the output of research. Looking at the parameters of resources we conclude that OCU is in charge of satisfactory control parameters but does not make use of them.

The Faculty Planning Board certainly is an expert decision-maker. However, it only represents broad knowledge of the different research fields. It is not in a position to arbitrate between different fields of research or between different faculties on the basis of a long-term research policy. Thus there is a "-" for both criterion 4 and criterion 5.

We conclude that neither A nor B is fulfilled by the subsystem OCU/TR. OCU is formally in charge of TR but does not exert full control and does not at all follow up the performances of the research programme.

RC/GT

This is not a complete subsystem since the research councils are not formally responsible for graduate training. Consequently the criteria concerning decision-makers are not relevant with respect to this system. There is no relevant feed-back or planning information.

The research councils are in charge of resource parameters that affect in quite an obvious way the conditions for graduate training. Thus the granting of scholarships and the establishment of research offices within projects increase the volume of graduate training at the university level.

Since graduate training is closely tied to research projects it is clear that the research councils should be interested in the outcome of graduate training. Even though criterion B is not fulfilled for this system there is reason to assume that the research councils are in the position to formulate requirements regarding the future volume of graduate training.

RC/TR

From a programme budgeting point of view this system is highly satisfactory. The programme areas are well defined through the government propositions and instructions for the councils. There is a good feed-back system in which reports continually go to the councils for follow-up. In many cases resources are no longer granted until satisfactory progress reports have been produced. The research councils and the sub-committees of the councils have members representing the most advanced research and knowledge that exists in the country within the research field in question.

The most striking disadvantage of the system is that the research councils do not control the whole programme area and therefore do not feel any responsibility for personnel employed by projects launched by the councils. Regarding feed-back the research councils do not have enough resources to follow up all reports being produced.

Our conclusion concerning the system RC/TR is that criterion A is not completely fulfilled while criterion B is satisfactorily met with. Long-term planning is an apparent characteristic of the work of the research councils as has been pointed out earlier. This long-term planning is, however, hard to realize since the councils themselves receive government grants for one year at a time.

KBS, UUH/UTE,GT,TR

The programme area of this system comprises buildings and equipment that the universities need in order to fulfil the main programmes. KBS and UUH do not co-operate but since they work in about the same way we treat them as one central agency in this system.

The obvious characteristic of this system is that the central agency is in charge of effective means of control of education and research without being in the position to make satisfactory judgements regarding needs and aims of the main programmes of the universities. Thus the decision-makers are experts on building and financing matters but do not fully grasp the problems of research and education. There is no feed-back from the programme area to the agency telling what effects new buildings and equipment have on the performance of the programmes. On the other hand, since all of these matters have to do with expensive capital investments, there is a well developed long-term planning system. We conclude that criterion B is satisfied . The system does not at all comply with criterion A.

## Summary

The organization for higher technical education and research in Sweden is based on three main programme areas :

A. Undergraduate technical education (UTE);
B. Graduate training (GT);
C. Technical research (TR).

At the university level each division is responsible for activities within all three programmes. This means that there is a considerable overlap between the programme areas at the performance level.

Different central agencies are responsible for the allocation of resources to the universities. The Office of the Chancellor of the Universities (OCU) is, according to the University Law, responsible for all three programmes. Regarding the research programme, OCU only provides higher offices and some basic financial resources for building service, equipment, library, administration, etc. OCU does not develop any research policy. The research councils on the other hand support individual research projects selected from applications from scientists or groups of scientists. These agencies do not feel any responsibility for basic resources necessary for the accomplishment of research.

Further, state and private foundations make additional grants to projects already supported by the research councils and OCU. Some divisions also take commissions from industry.

The preceding analysis of the organization makes clear that measures of re-organization have to be applied if we want to establish a working programme budget system for graduate training and research. We give two fundamental guidelines for improvements.

1. The central controlling units must be given specified programme areas in terms of the three main programmes. Overlap of responsibility should be avoided. It seems appropriate to make OCU responsible for the graduate training programme. The research councils are best prepared to be in charge of the research programmes - in this case we mean responsibility for all resources that go into research. For this purpose fields of research have to be defined for each research council so that it is clear what kind of research the council is expected to control.

2. An improved information system is necessary for two reasons :

   i) The central agencies have to co-ordinate their objectives and plans. At the university level it is important that there is a balance between the volumes of the programmes;

   ii) A functioning programme budget system requires feed-back channels. Information about performance, effectiveness and goal fulfilment of the programme has to be passed on to the central controlling agency to give the basis for further allocation of resources.

These conclusions are just hints at the outcome of this report. A detailed treatment of a proposed organizational model and information system will be given in Chapters 7 and 8 of this report.

## Chapter 4

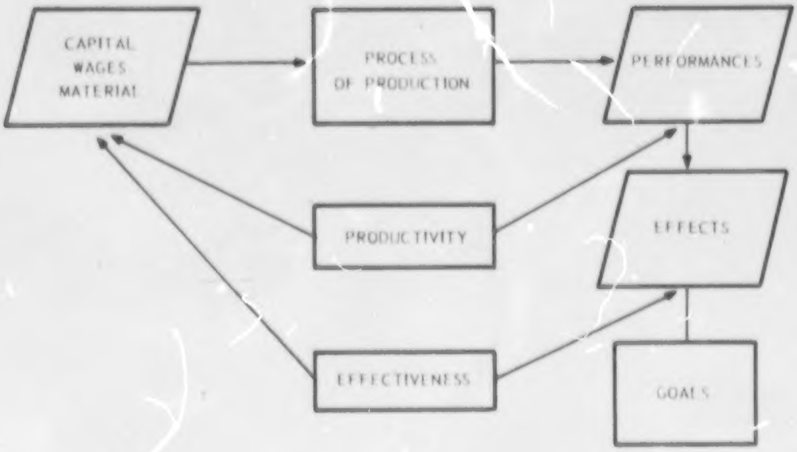
# A QUANTITATIVE DESCRIPTION OF HIGHER TECHNICAL EDUCATION AND RESEARCH AT CHALMERS UNIVERSITY OF TECHNOLOGY

## 1. INTRODUCTION

An effective programme budgeting system is dependent upon a steady flow of information. The central and local controlling units are both interested in cost and performance data of the production process. Measurements of output constitute the basis for evaluating effects and the relationship between goals and effects. The following definitions should be kept in mind when reading the tables in Appendix I (to be found at the end of the report).

Figure 4.1

BASIC PPBS CONCEPTS


CAPITAL
WAGES
MATERIAL
PROCESS OF PRODUCTION
PERFORMANCES
PRODUCTIVITY
EFFECTS
EFFECTIVENESS
GOALS

- Degree of goal fulfilment is a relationship between effects and goals of the production.
- Productivity is a measure of the relationship between the volume of output and the costs of production.
- Effectiveness is a corresponding measure of the relationship between the effects and the costs.

Figure 4.1 illustrates the concepts.

The purpose of this chapter is to give a survey of the volume of the activities at Chalmers University of Technology. Four main types of data will be presented :

1. Total costs of programmes and subprogrammes.
2. Measurements of performances and effects.
3. Productivity and effectiveness data.
4. Relationships between the main programmes.

Assuming that graduate training and research can be separated regarding costs we shall now divide the activities into three main programmes :

I. Undergraduate Engineering Education;
II. Graduate Training;
III. Research.

The data presented makes it possible to relate some of the figures found in the pilot study (presented in Chaper 5) to total figures of the university. Further, the collection of data gives an idea of how an improved information system should be designed in order to produce the necessary information. In section 2 we present the background material that is available today. Before making final conclusions in section 4 we present in section 3 some detailed comments to the tables in Appendix I.

## 2. BASIC DATA AND DEFINITIONS

Since the introduction of PPBS at CTH in 1968 the programme budget group has collected information about the different activities of the university. As was pointed out, PPBS requires a lot more detailed data regarding costs and output than was necessary in the old system. Special interest was paid to the Programme Budget Proposal and the division budget. The material collected by the programme budget group forms the main part of our background material presented below.

1. A Shadow Budget Proposal of 1970/71 made up during the fiscal year 1968/69. The first preliminary measurements of productivity in undergraduate education were presented in this proposal. The Proposal is based upon budgets made up by the divisions and put together at the department level.
2. Programme Budget Proposals of 1971/72 and 1972/73. These proposals comprise total costs for the programme defined at CTH and they constitute the basis for the budget requests.
3. Division and Department budgets of 1970/71. We used the adjusted version, that is the budgets made up after the actual allocation to the divisions was known. In order to collect information for the division budgets, course budgets were made up for each course giving the costs for different kinds of teachers, materials and special services involved in the course. The course budgets cover both undergraduate and graduate courses. Project budgets were left out from this first budget procedure. The data regarding research are therefore very uncertain.
4. Department plans of activities. These plans comprise the figures concerning man days devoted to education and research. The evaluation of these figures was based on the division and department budgets.
5. Statistical material concerning examination and graduation in undergraduate education. During the last 5 years the administrative section for higher education at CTH has developed methods of following up the student performances. The measurements that are used are of great value to the programme budget work.

Before going into the individual tables we shall make some general comments on the calculations.

"Total costs" means all costs except for the so-called complementary costs which include rents and depreciations. The following table gives the size of the complementary costs in the last fiscal years.

Table 4.1

| Fiscal year | Rents (%) | Depreciation (%) | Compl. costs (%) |
|---|---|---|---|
| 1968/69 | 12.0 | 6.3 | 18.3 |
| 1969/70 | 17.1 | 9.5 | 26.6 |

The percentage is to be calculated on the total costs.

The programme grant is the total support that Chalmers University of Technology receives. Among the revenues we find "The Faculties of Mathematics and Natural Sciences" and "Faculty of Social Sciences". This appropriation is supposed to cover expenses for that part of education and research that take place at these faculties at Chalmers. A number of divisions, for example the Division of Physics and Mathematics, belong to both the Faculty of Technology and the Faculties of Mathematics and Natural Sciences. This is a special and somewhat complicated arrangement from an administrative point of view and we shall not go further into the problem. The programme grant does not include costs for doctorate scholarships, computer time, special arrangements for graduate training, reduced teaching duties for higher offices and joint building service. These costs are covered through other grants in the Government Budget Proposal. The general structure of the costs for the university is outlined in the following table.

Table 4.2

| Notation for the grant in the Government Budget Proposal 1971/72 | Costs/Revenues | Notation for totals |
|---|---|---|
| Proposal of 1971/72 | Salaries and remunerations<br>Materials and equipment<br>Other direct costs | |
| | Total direct costs | A |
| | Management<br>Library<br>Other joint costs | |
| | Total indirect costs | B |
| | Total costs | A+B |
| | External revenues | |
| E44 | Computer time | |
| E23 (1970/71) | Reservations | |
| E21 | Compensation for reduced teaching duty | |
| E27 | Building service | |
| E41 | Doctorate scholarships | |
| E42 | Special arrangements for graduate training | |
| E11 | Faculty of Social Sciences | |
| E19 | Faculty of Mathematics and Natural Sciences | |
| | Total revenues | C |
| | Programme Grant | A+B-C |

Direct costs are such expenses as can be referred to a programme by looking at the nature of the expense. For instance a salary for a teacher or a scientist is a direct cost since a report from the appointee or how he uses his time tells us how to let the salary charge the programmes.

Indirect costs we do not know how to charge the programmes. Therefore most indirect costs are allotted to the programme in proportion to the direct costs.

External revenues are grants received from research councils, foundations and industry.

Reservations. The present programme grant is a reservation grant which means that the university may not overdraw the account but the remaining part of the grant may be reserved for the next fiscal year.

Compensation for reduced teaching duty. The Board of University may reduce the teaching duty for a professor and associate professor from 132 hours/year to minimum 116 hours/year. Costs for appointing substitutes are covered through a special government grant.

The programme structure of the background material is different from the one suggested in section 1. Thus there are at present five programmes defined for CTH.

P1 : Undergraduate Education, CTH
P2 : Undergraduate Education, GU
P3 : Research and Graduate Training, CTH
P4 : Research and Graduate Training, GU
P5 : External Services.

GU stands for University of Gothenburg and the programmes P2 and P4 cover the activities at CTH of the Faculty of Social Sciences, Faculty of Mathematics and Natural Sciences. In the calculations of the volumes we used the following modified programme structure :

I. Undergraduate Engineering Education
II. Graduate Training, CTH+GU
III. Research, CTH+GU.

## 3. DESCRIPTION OF THE PROGRAMMES

The appendix of tables (see Appendix I) is divided into four parts and we shall here comment on these parts.

Undergraduate Technical Education [Tables 1(a) - 1(d)]

Since the schools of education are the units of interest all figures are referred to schools. The total costs are found from the course budgets for the courses taught at each school. The costs vary with the year of study and increase as the number of the years increases. The total costs also include costs for examination works.

The nominal (nom) number of students is the number admitted according to enrollments lists. This is obviously not the real number of students since many students are delayed or drop out. However, the students' registration does not allow an exact calculation.

Total costs per student is a measurement of productivity. Since between 80 and 90 per cent of the students admitted finally graduate, the measurement also gives some idea of the effectiveness. A better measurement of effectiveness is offered by total costs per graduate engineer. The figures presented are more uncertain since the medial time of study is measured only for one class of students. The registration of students is continually improved and thus this latter measurement can be expected to become more accurate in the future.

The student faculty ratio (SFR) is defined by

$$SFR = \frac{A}{B}$$

where :

A = total number of student hours of work

B = total number of teacher hours of work.

This is a valuable measurement of productivity. However, there is great uncertainty in both A and B and therefore the SFR should probably not be used at present in connection with budgeting. If time reports are required from both teachers and students the measurement could be improved.

Graduate Training, CTH+GU [Table 2(a) to Figure 1]

Total costs for 1970/71 are marginal costs, that is, total costs calculated from the divis[illegible] budgets covering graduate courses, assistant time devoted to individual studies and certain expenses for travel and publication. As will be further pointed out in connection with the pilot study it is hard to recognize special graduate training activities, such as supervision, since most of the process of graduate training is integrated with research work.

The registration of graduate students was initiated in connection with the proposal of a new graduate training in 1969. The information flow from the divisions to the central administration is so far very poor and therefore the number of graduate students is rather uncertain. In order to give a fair picture of the cost for each graduate student we use the concept full-time-equivalentgraduate students (FTEGS) and make the following assumptions.

Graduate student with doctorate scholarship = 1 FTEGS
Graduate student with appointment as
assistant lecturer = 0.5 FTEGS
Graduate student with other appointment = 0.5 FTEGS

With these assumptions we receive the FTE number of graduate students. It should be pointed out that all data concerning graduate training are referred to departments.

Since the total costs of graduate training are marginal costs it is rather meaningless to calculate total costs per FTEGS. However, if the Office of the Chancellor is to be fully responsible for the costs of graduate training but not at all responsible for the costs of research this measurement of productivity has to be refined.

Like SFR for undergraduate education we give the number of students per supervisor for graduate training as an illustration of another measurement of productivity. In this case we use the nominal number of graduate students since each student can be assumed to occupy the same time of supervision independent of other activities. The number of students per supervisor is assumed to be an important figure since it could be the basis for establishing offices for supervisors.

The concept "supervisor" includes the following types of offices :

Professor
Associate Professor
Assistant Professor
Research Assistants

that is, all offices, except lecturer, for which a doctor's degree is required.

The structure of costs of graduate training is based on Table 4.2 in section 2. Evidently most of the costs (90 %) are covered by the programme grant. The structure of costs is calculated from the Programme Budget Proposal of 1972/73.

Research, CTH+GU (Table 3(a) to Figure 2)

Total costs for research include some of the costs for graduate training. Since all the costs are calculated from the division budget and not from project budgets it is hard to tell what costs actually belong to graduate training.

A measurement of the volume of the research programme is the number of scientists with at least a doctor's degree. The relationship between total costs and this number of scientists can be used for two purposes :

1. As an illustration of the kind of research that is going on. Extremely theoretical research displays low costs per scientist while experimental development work displays the highest costs.
2. As a basis for a judgement whether the volume of the research staff is satisfactory. Too high costs per scientist indicates that the staff is over-exploited while low costs indicate over-capacity.

In Table 3(a) the number of scientists is calculated on the basis of offices and therefore some of the scientists are not doctors.

The best output measurement found so far is the number of man-days of research per year that the division or research group performs. With some experience of research this measurement can be used for making up research plans for the division and thus estimating the total research capacity of the division.

We point out that the measurement of total costs per man-day is calculated for research and graduate training together. This measurement has about the same property as total costs per supervisor. The former is more refined but at the same time more uncertain since the scientists do not produce time reports.

Other measurements of output, productivity or effectiveness in research have not been tested in the investigations preceding this report. However, different possible measurements have been debated with scientists at CTH as well as with representatives of the research councils. A review of the these discussions will be presented in Chapter 6.

The structure of costs for the research programme, calculated from the Programme Budget Proposal of 1972/73,gives an idea of the relationship between basic resources paid by the programme grant and marginal project costs financed through external revenues. All costs are referred to departments. It is important to note that department E includes the Onsala Space Observatory.

### Relationships between the Main Programmes (Tables 4(a) - 4(d)

Making the assumption that a certain balance between the main programmes favours the efficiency of research and education, we calculate some relationships between the programmes.

The number of man-days in this case includes man-days for all offices involved in the activities of the division except for technical and administrative service personnel. Thus everyone from the professor to the assistant lecturer is included.

The relationships between costs for the main programmes are calculated from the figures presented under the separate programmes. Of course these relationships represent no measurements of output or efficiency. They only give a rough idea of the volumes of the programmes for the departments and the university as a whole. However, these figures could preferably be compared to measurements of output and efficiency of the programmes, especially the research programme.

## 4. CONCLUSIONS

The tables of Appendix I offer basic data for an analysis of the factors affecting the characteristic output parameters of the programmes. In this paragraph we shall concentrate on :

i) Productivity of the programmes;
ii) Financing the structure of the programmes;
iii) Relationships between the volumes of the programmes.

Since undergraduate engineering education is subject to analysis in previous reports we do not treat this programme specifically.

### Graduate Training

The important measurement of productivity is the yearly cost per graduate student and full-time-equivalent graduate student presented in Tables 2(a) - 2(c). We assume that the following three factors affect the productivity of graduate training :

1. Nature of research work (experimental, theoretical);
2. Total number of graduate students of the department;
3. Number of graduate students per supervisor.

The following table displays relevant data selected from Appendix I.

Table 4.3

| Department | Ph. math. | Ph. phys. | M | E | C | Ch | A | CTH |
|---|---|---|---|---|---|---|---|---|
| Total costs/FTEGS 1970/71 (ThSwCr) | 33.8 | 19.7 | 25.9 | 46.8 | 43.6 | 16.7 | 25.8 | 26.9 |
| Nature of research | Theor. | Theor/Exp. | Exp. | Exp. | Exp. | Exp. | Theor. | |
| Total number of graduate students | 65 | 140 | 129 | 104 | 51 | 218 | 35 | 742 |
| Number of graduate stud. per supervisor | 4.6 | 6.1 | 6.5 | 5.2* | 3.2 | 8.1 | 4.4 | 5.8 |

In the first place we notice that a high number of graduate students go together with a high number of graduate students per supervisor. The difference between departments C and Ch clearly shows that a big volume of graduate training makes each graduate student cheaper. The same conclusion appears when we compare Ph. math. and Ph. phys. When Ph. phys. and M are compared, the result is that theoretical research is cheaper than experimental. It is dangerous to draw too detailed conclusions from these figures, since this whole investigation is characterized by the difficulty of distinguishing between costs and time utilized for graduate training on one hand and research on the other.

A glance at the financing structure of graduate training shows that external revenues and special grants for graduate training are of little importance. From Table 2(g) we get the following percentages calculated on total costs :

| | |
|---|---|
| Programme grant : | 90.6 % |
| External revenues : | 1.7 % |
| Special grants for GT : | 1.2 % |
| Doctorate scholarships : | 3.8 % |

Special grants for graduate training is a OCU grant that was introduced in 1969 to improve the conditions for the new doctorate education. Obviously the grant does not considerably improve the situation. We also conclude that there is reason to say that OCU is almost to 100 % economically responsible for the graduate training programme.

## Technical Research

The only productivity measurement that is available is total costs per scientist, which of course is a very poor one. However, from Table 3(a) we immediately conclude that this measurement is a function of the nature of research. Both Ph. math. and A display low costs per scientist while the most experimental departments C and Ch have the highest costs per scientist.

The financing structure of the research programme can be studied in Figure 2. An average of 41 per cent of total costs is contributed by external revenues. Ph. phys., C and A show the highest external contribution, which can be explained by the fact that the research programmes of these departments correspond to the area of responsibility of the research councils ARC (Ph. phys.) and BRC (C and A). The other departments have to apply for research grants at more than one research council. It should be pointed out that BTD grants resources to all of the departments except A.

There is no research council for mathematics or applied mathematics which means that Ph. math. is primarily dependent upon the programma grant.

M, E and Ch are more related to industrial research. They display the highest percentage of commission revenues. Since regulations for making commission contracts tend to make the divisions uninterested in such contracts the total percentage of external revenues is kept at a low level for the departments M, E and Ch.

## Relationships Between the Main Programmes

The relationship between the volumes of the main programmes is an important parameter for two main reasons.

1. Although the programmes are controlled by different central agencies they have the level of production in common - the division.
2. For most of the offices there are regulations concerning teaching obligations and supervision. Therefore each appointee at a division is supposed to divide his time of work in a certain way between the programmes. The relationship between the volumes of the programmes gives us an idea of how this is done.

The following table gives the relationships between the volume of costs of the main programmes calculated on the basis of Figure 4. As has been pointed out earlier there is a good correspondence between schools and departments and therefore we may compare undergraduate engineering education with graduate training and technical research in this way.

Table 4.4

| Cost Relationship / Department | Ph | M | E | C | Ch | A | CTH |
|---|---|---|---|---|---|---|---|
| UTE/GT | 3.0 | 3.7 | 2.7 | 5.8 | 3.6 | 6.0 | 3.6 |
| UTE/TR | 1.1 | 1.6 | 1.3 | 1.3 | 0.7 | 2.3 | 1.1 |

The figures for Ph and C are actually smaller than they should be since undergraduate education for the University of Gothenburg is not included, while research and graduate training on the part of the teachers involved are included in the costs of GT and TR.

Department A displays somewhat odd figures which emanate from the fact that research and development in these disciplines to a great extent is associated with undergraduate education.

Figure 4 further shows that the proportion occupied by graduate training is fairly constant over the departments. Department E has the highest proportion GT which is explained by the intensified graduate training and research activities at Onsala Space Observatory. At department C the volume of graduate training is below average primarily because most of the graduate engineers are attracted to well-paid development projects in industry.

The relationship between UTE and TR is about constant. We shall look for the reason along two lines.

1. The structure of high offices;
2. The nature of the offices for assistant lecturers.

The structure of high offices is analysed in the table 4.5

Teaching obligation expressed in % UTE is calculated on the basis of the University Law and the assumption that each class hour requires two hours of preparation. We find the following rules for the offices. All percentages are calculated on the basis of 1600 hours of work per year.

- Professor, associate professor : Teaching obligation is 132 lecture hours per year which means 396 hours per year for UTE.
- Assistant professor : is supposed to teach 75 hours per year which means 225 hours per year for UTE.
- Research assistant : 198 hours of teaching per year.
- University lecturer : 396 hours of teaching per year.

Table 4.5

| | Number of offices 1970/71 | | | | | | | Teaching obligation % UTE |
|---|---|---|---|---|---|---|---|---|
| | Ph | M | E | C | Ch | A | CTH | |
| Professor Associate prof. | 23 | 17 | 14 | 14 | 16 | 8 | 92 | 25 |
| Assistant professor | 5 | 1 | 1 | 0 | 4 | 0 | 11 | 14 |
| Research assistant | 6 | 2 | 2 | 2 | 7 | 0 | 19 | 38 |
| University Lecturer | 22 | 10 | 13 | 10 | 4 | 2 | 61 | 75 |
| % UTE (calc) | 45.0 | 42.2 | 47.2 | 42.0 | 33.0 | 35.0 | 42.4 | |
| % UTE (Table 11) | 31.5 | 50.3 | 40.4 | 52.5 | 20.6 | 33.0 | 35.4 | |

% UTE calculated in Table 4.5 is the weighted average dependent upon the number of appointees and the teaching obligation. We compare these "theoretical" values to the man-day load data presented in Table 4(d). The correspondence is fairly good and we conclude that some of the departments are overloaded by UTE (M, C) while the others display overcapacity. It is obvious that the structure of offices to a great extent is the basis for a balance between the programmes.

The second line of explanation has to do with the assistant lecturers. They take care of a great deal of UTE at the same time as they try to spend as much time as possible on GT and TR. They represent an important coupling between the programmes. The rules for the assistant office state that an assistant is supposed to devote 1000 hours per year to divisional work. In practice the assistants usually have 250 class hours per year. In this way they may spend more than 50 per cent of their time on GT and TR. However, at divisions overloaded by UTE the assistants may be over-exploited, which usually means that research and graduate training are delayed. Thus the assistants are used as instruments of control of the balance between the main programmes.

Chapter 5

# A PILOT STUDY OF THREE DIVISIONS AT CHALMERS UNIVERSITY OF TECHNOLOGY

## 1. INTRODUCTION

For the general purpose of getting a more detailed picture of the costs, activities and achievements of GT&R a pilot study was undertaken during phase 2 of the project covering about 2 months of work. We first list the most important objectives of this pilot study.

1. To develop methods for analyzing divisions with respect to time utilization, structure of costs, performance, productivity, etc.
2. To give a qualitative and quantitative description of the activities within the programme GT&R for the purpose of developing a preliminary programme budget model to be applied at the university as a whole.
3. To compare divisions of different character with respect to :

   - size of division
   - methods of research (experimental, theoretical)
   - nature of research (basic laboratory work, development work close to applications, theoretical development of methods)
   - degree of external support (grants from research councils, foundations, etc.)
   - extent of external commissions
   - number of graduate students
   - structure of personnel.

The whole pilot study is divided into the following activities.

A. Selection of divisions.
B. Survey of time utilization.
C. Cost accounting.
D. Survey of rooms and equipment.
Development of output measurements.

Divisions were selected on the basis of the criteria mentioned above. After discussions with university officials and representatives of different divisions it was possible to make the final selection of three divisions which we present in the following table.

| Division of | Abbr. | Department of |
|---|---|---|
| Applied Electronics | DAE | Electrical Engineering |
| Soil Mechanics and Foundations | DSM | Civil Engineering |
| Theoretical Physics and Mechanics | DTP | Engineering Physics |

The results of the pilot study for one of the divisions (DAE) will be found in Appendix II B.

## 2. SURVEY OF TIME UTILIZATION

A study of time utilization involves a number of different phases. We did not intend to make a pure scientific study but rather a study giving us a rough picture of what activities take place and how time is allotted to these different activities.

### Activities

Through interviews and a general knowledge of educational and research work we arrived at a list of activities common to the divisions to be studied. The activities are presented in Appendix II A at the end of the report. The activities are grouped into programmes so as to make the names and codes easier to identify. However, administration is not to be regarded as an independent programme. Thus those tasks performed by technical and administrative service personnel and which can be associated with UTE, GT or research activities should be referred to these activities. For instance transcription of theses and articles is to be referred to activity 35.

### The investigations

Since very short time was available for this time utilization survey we decided to make two parallel investigations.

I. A work report covering one week. We selected one week at the beginning of May 1971 for this report.

## II. A time utilization survey of the past year.

All personnel were asked to fill in forms worked out for each type of investigation.

In the work report all tasks during the week were to be listed. For each task the appointee was asked to give :

- Time devoted to the task with an accuracy of half an hour.
- Programme to which the task is to be referred.
- Activity code.
- Room in which the task was performed.
- Equipment used.
- How often the task is repeated (daily, weekly, every month, etc.).

Concerning programmes, rooms and equipment special code lists were worked out for each division. By programme we mean divisional programme. Here we divided the research programmes into subprogrammes comprising different kinds of research performed by the division. The other programmes, Undergraduate Education and Graduate Training, correspond to the main programmes of CTH and were not subdivided.

The rooms were classified into main groups :

1. Office rooms
2. Rooms for seminars and meetings
3. Laboratories
4. Division library
5. Remaining division rooms
6. The University Library
7. Other external rooms or places.

The form of the time utilization survey gives alternatives for describing the time devoted to the different activities. The personnel filled in this form right after the work report and therefore they could be expected to be conscious of their activities and the time devoted to these activities. The alternative should be clear from the form. We shall make a few general comments on the investigation.

Obviously one week is not enough for a work report. Preferably a number of significant weeks throughout the year should be selected for the report. This would give a more correct picture of the activities. The activities are usually unevenly distributed over the year. For instance examination activities are concentrated into special examination periods. For each course three examination opportunities are to be offered every year.

Two special circumstances were involved in our investigation. In the first place there was a labour conflict covering about three weeks in February and March. This meant extra educational work for the teachers in the following months. In the second place 1 July was set as the last date for passing the old licentiate exam. Thus many graduate students spent all for their time finishing their doctor's thesis before that date.

Since the time for each task was to be given within half an hour there are many minor tasks that are not included in the work reports. These minor tasks, such as telephone calls, short discussions, cleaning, are usually hard to grasp in a time utilization report of this kind. On the other hand we do not require such a high degree of certainty in this report but rather a rough key of how to allot salary costs to the different programmes.

The conclusions to be drawn from the results of the time utilization report will be found in section 6.

## 3. COST ACCOUNTING

The analysis of the structure of costs for the division is based upon a division budget form (Table 8, Appendix II B). The idea of this form is the same as for the structure of costs presented for the university as a whole in Chapter 4. Thus column 1 is reserved for the names of the costs, the resources and the corresponding totals. Columns 2 through 11 are reserved for courses and projects. "Remaining graduate training" is an exception but has to be included in order for the budget to display total marginal costs for graduate training. Columns 12 through 17 cover assistant accounts of costs. It was necessary to define different assistant accounts of costs for the divisions involved in the pilot study depending upon the internal accounting system.

On page 2 of the division budget the total costs of the assistant account of costs are allotted to the direct carriers of costs according to keys especially defined for each division. Lacking special tools for this allotment we were in most cases bound to allot these costs in proportion to total direct costs for the carriers of costs.

In order to find the portion of the total costs to be covered by the programme grant we have to deduct external and other resources from the total costs.

It should be noted that complementary costs do not go into the division budget. It is not yet known what percentage is to be added to the total costs for the fiscal year 1970/71 in order to include all costs (cf. Table 4.2 of Chapter 4).

When collecting material for the division budget two methods were applied. In the first place we made use of the internal bookkeeping of each division. However, in some cases these documents were very incomplete. In this connection we note that special bookkeeping at each division is not compulsory.

The second method of cost accounting was based upon the computer lists. During the last fiscal year a computer system for cost accounting (the national SEA-system) was applied to Chalmers University of Technology. The person responsible for an account makes notes on each bill and sends it to the cashier's office. The bill is left for punching and the expense or revenue is registered by the computer. Every month a disposition list is produced by the system giving the balance of each account. Every three months there is a list of costs produced giving a detailed account of the types of costs/expenses that have passed the accounts. Since most of the appointees are not used to the system the accounting has not functioned well during the fiscal year 1970/71. However, as a complement to the internal accounting we used the list of costs produced at the end of the fiscal year for collecting material for the division budgets.

A comparison between the division budgets received from internal bookkeeping and the ones received from computer lists shows that the discrepancies regarding total costs are less than 10 per cent in most cases. Administration is one important exception. The distinction between administration, duplication and in some cases, supply is far from being clear.

A disadvantage of the budget form is that it does not display how certain revenues have been used, i.e. for what types of costs. From a programme budget point of view this is an irrelevant criticism. However, in the present system there is a general requirement to account for how specific grants have been used. The problem is easily solved by having page 1 of the budget written out for each grant which is to be separately accounted for. The different subbudgets are then added before the costs of the assistant accounts are allotted.

The distinction between costs for materials and costs for equipment is not clear. This problem is a consequence of the lack of investment planning at the division. The line for "equipment" in the budget form is in the first place reserved for expenses for equipment that is to be regarded as investment.

The division budget form presented in this section is more adapted to the claims of programme budgeting than the earlier forms were. However, we have to recognize that the individual scientists, teachers and administrators at the division still think of grants as being intended for certain fixed types of costs. Therefore it is probably necessary to use the old budget forms, separating the costs with regard to grants, for another year until programme budgeting has reached that level of consciousness when it is self-evident that the grants are to be used to cover the needs in the way the division finds most favourable with respect to an optimal performance of the programmes.

## 4. SPACE AND EQUIPMENT

Special investigations are at present being carried out for the purpose of improving registration and the use of rooms and expensive equipment. We do not therefore make any ambitious accounts of rooms and equipment that the divisions dispose of.

Most of the rooms that are given to the divisions are intended for research and graduate training. Lectures and classes in undergraduate education take place in joint halls supplied by the central administration. The only rooms of the division that are utilized to any extent by undergraduate education are office rooms (in proportion to salaries of the users) and laboratories. The rest of the rooms are considered to be resources for the research programme. For calculations we assume a rent of 180 SwCr/m2 year.

The divisions usually buy equipment with special grants and gifts from public and private foundations. These grants are usually applied for at the same time as project applications go to the research councils. Even grants from the research councils may be used for equipment. In this case the equipment actually belongs to the research council that made the grant and may be removed by the council when the project is finished. In connection with the establishment of new buildings the divisions that move into a building at the same time receive a general grant for new equipment from the LUP-committee.

Cost of equipment consists of two components :

i) costs of depreciation;
ii) interest.

In this investigation we only take the grants from the LUP-committee into account. If this grant is set to E SwCr the two components of equipment costs are calculated in the following way.

- Cost of depreciation : We assume a linear depreciation covering 10 years. This means a yearly cost of depreciation of E/10 SwCr.
- Interest : We first calculate the current initial outlay for the

equipment based on a yearly inflation of 5 per cent. We arrive at a current initial outlay of $C = (1 + 10X \frac{5}{100})E$ SwCr after 10 years. The interest is evenly distributed over the time of utilization and thus the yearly interest is

$$I = \frac{8C}{100} = \frac{8}{100}\,(1+10 \times \frac{5}{100})E = 0.12\ E$$

where a rate of interest of 8 per cent is assumed.

## 5. OUTPUT

The only measurements of output that we apply in this report are performance measurements. The performance measurements are :

Undergraduate education

Number of teaching hours
Number of passed exams
Number of graduate theses

Graduate education

Number of graduate students

Research

Number of man-days devoted to the different research programmes.

For a discussion of the measurements of effects we refer to some general considerations of output measurements presented in Chapter 6.

## 6. CONCLUSIONS

In accordance with the general objectives of our pilot investigations this section comprises two discussions, one on the problems involved in the method of investigation and the other on the data obtained for the three divisions.

### The Method of Investigation and the Programme Structure

1. During the process of selecting divisions we found that a great many divisions do not fit into our programme structure in a natural way, i.e. the division of activities into undergraduate technical education, graduate training and technical research. Especially small divisions (less than 25 employees) function as administrative and economic units. The scientists and graduate students generally participate in all of the programmes.

It is particularly hard to distinguish between graduate training and technical research since the major of the graduate training programme is the project work. When the list of activities were looked at most of the participants in the investigation were not able to make a clear distinction between the supervision belonging to graduate training and scientific discussions concerning research projects tied to the technical research programme.

We conclude that Graduate Training must be regarded as an additional programme in which the central authority is responsible for those special activities of graduate training that the Technical Research Programme does not cover. Such activities are special graduate courses, the printing and publication of theses and participation in general symposia or conferences. An important activity of graduate training is the preparation that a supervisor has to make in order to get a graduate student started. If no well-defined projects are available the supervisor has to develop new project plans. This kind of work may, especially in theoretical research, require many months of work.

2. The other two main programmes, Undergraduate Technical Education and Technical Research, were easier to identify for the participants. However, we have to recognize that since the division functions as a unit the programmes are dependent upon each other. When an examination worker performs thesis work for a research project it is hard to tell what programme is to be responsible for the expenses. Many activities belong to all of the programmes. To make a survey of available literature or to take part in a conference often favours all of the programmes. It is in these cases especially that it is impossible to refer the activity to any of the subprogrammes of technical research.

3. The fourth programme on the list of activities, Administration, was primarily intended for technical and administrative personnel who are responsible for general service functions in the division. If possible, all administrative tasks should be referred to one of the main programmes. We observe that time devoted to administration by technical and administrative personnel is less than 50 per cent of total time, which indicates that most of the administrative tasks can be referred to main programmes.

At the Division of Theoretical Physics and Mechanics the staff is divided into sections, research sections and a section for undergraduate education. Administrative personnel devote less than 20 per cent of their time to programme Administration which indicates that they are more conscious of the purpose of administrative tasks than are the over divisions.

4. The list of activities has to be worked out in close co-operation with the participants of the investigation. If the same list of activities is to be used by all divisions of the university a number of special activities have to be defined for some divisions. Thus the general activities "experimental research" and "theoretical research" have to be divided into subactivities relevant to each division. Examples of such subactivities are :

   Calibration of instruments;
   Computations;
   Tests of components of experimental equipment;
   Service of equipment.

   The purpose of their subdivision would be to make it easier for each employee to identify his tasks with activities in the list and thus make it easier and faster to fill in the forms.

5. The purpose of the one-week work report was to collect general information about the tasks performed by divisions and to make everyone think about how time is utilized. It is obvious that some kind of "activating period" is necessary in order to have the personnel estimate how their time is utilized for different activities in a longer period (one year). Since there is very little routine work at a scientific division, one week is too short a time to reach this goal. Many types of tasks, e.g. examination, conferences, budget work do not appear in this interval of time.

6. The time utilization survey concerning one year was to display information, in the first place, concerning the time devoted to the main programmes and administration and, in the second place, concerning the volume of specific activities. After having checked the plausibility of the percentages we considered it possible to use these reports as a basis for allotting the salary costs. At the division of Theoretical Physics and Mechanics it was possible to compare data from our budget form with an investigation made independently at the division.

| | % of total costs | | | | | | |
|---|---|---|---|---|---|---|---|
| | Programme | | | | | | |
| | UTE | GT | FT | E | ST | M | ADM |
| Our budget form | 45.8 | 11.3 | 10.7 | 13.7 | 6.3 | 4.0 | 8.2 |
| Separate investigation | 30 | 21 | 19 | 18 | 4 | 3 | 5 |

The correspondence between the investigations is not good. Obviously the employees spend too much time on undergraduate education. This is an especially relevant observation concerning the university lecturers who are supposed to spend almost all of their time on undergraduate education. However, general experience indicates that most of the university lecturers participate in the research programme. A time utilization survey like the one presented does not display such circumstances as these, since the employees preferably give figures in accordance with the existing rules. Our conclusion is that a time utilization survey has to be more refined in order to constitute a relevant basis for the allotment of salary costs. Probably continual time reporting has to be performed for a couple of months in each division under investigation.

7. Concerning space and equipment we only have made very crude approximations. Special investigations are at present being undertaken and we shall therefore await the results before making any further surveys.

8. The division budget form emanates from discussions and interviews with various representatives of the economic function of the divisions. One of the main problems is to recognize the difference between costs and appropriations. The traditional appropriations always included detailed instructions concerning what kind of expenses they were supposed to cover. Thus there is a general tendency among employees at the university to associate each appropriation with a type of cost. The new budget form (page one of Table 8, Appendix II B) analyzes the structure of costs and on page two the financing structure. Experience so far indicates that permanent use of the form may require a year of preliminary testing. During this year the personnel will be expected to become acquainted with the concept of programme grants.

Analysis of Primary Data

In Appendix II C we have selected data from the pilot study in such a way that the three divisions can be compared to each other with regard to relevant quantities. In general each programme is represented by four types of quantities :

i) Volume of performance;
ii) Financing structure;
iii) Structure of costs;
iv) Costs per unit of performance (reciprocal productivity).

With regard to undergraduate education and graduate training, the financing structure is of no interest and consequently it is left out. The appendix is concluded by a comparison of costs of the auxiliary functions and of total costs of the main programmes. In the following text we comment briefly on the data presented.

1. Table 1. A small portion of the teaching obligation is utilized for undergraduate education. Our time utilization survey indicates a higher degree of utilization than does the relative teaching load. We again conclude that the time utilization survey shows too much time devoted to undergraduate education. DTP belongs to the traditional sciences and thus this division received its high offices during a period when the educational system expanded considerably. In later years the establishment of new offices was strictly confined and consequently expanding divisions like DAE and DSM displayed a lack of higher offices.

2. Table 2. Assuming that each period requires three hours of preparation we arrive at a standard teaching load of 0.25. Comparing this figure to the ones presented leads to the following conclusions :

   DAE is somewhat overloaded;
   DTP displays a normal load;
   DSM has an overcapacity regarding undergraduate education.

   At all of the pilot divisions external research assistants spend about 10 per cent of their time on undergraduate education.
   The assistant lecturers normally spend 40-50 per cent of their time on undergraduate education. This percentage increases when :

   i) Higher offices contribute less to UTE;
   ii) Teaching load increases;

iii) Other categories of personnel (except for higher offices) do not take part in UTE;

iv) There is a general aversion to UTE.

At DTP there is reason to assume that 10 per cent of the UTE is handled by "expert" leaders. 90 per cent is taken care of by scientists who are primarily interested in their research programme and who look at UTE as something they just have to do.

3. Table 3. UTE is more expensive at DTP due to the traditional structure of salary costs. Since there are no experiments in the education offered by DTP the total costs per period would be expected to be cheaper at DTP than at DAE and DSM, the latter divisions being definitely experimental.

4. Table 4. The small number of graduate students per supervisor at DTP is again explained by the traditional structure of salary costs. The relationship is confirmed by the time utilization survey (student time supervisor time).

5. Table 5. Costs per graduate student are somewhat lower at DAE and DSM due to the fact that a larger portion of the graduate students are employed as assistant lecturers. Only a small portion of assistants' salaries charges the GT-programme while the graduate scholarships are considered to be costs of GT.
Costs per man-day are considerably higher for CTH than for the pilot divisions owing to the fact that the total costs of GT at the CTH-level include all of the assistant salaries and also some joint costs not included in the costs for GT at the pilot divisions.

6. Table 6. The research programme of DAE is characterized by many small projects. DTP and DSM both have about one project for each scientist.
In applied research (DSM and DAE) the relative contribution of technical and administrative personnel is 4-6 times greater than purely theoretical research (DTP).

7. Table 7. The divisions of applied research receive relatively more resources from the research councils. This is an expected result since government propositions in general favour applied research. In the case of DSM the research of the division is primarily controlled by BRC and consequently this research council is responsible for the main part of the resources.

8. Table 8. DTP is characterized by a high percentage of salary costs and costs for computer time. At DAE and DSM more resources go to materials and equipment. Especially DAE makes current use of computers but disposes of a computer together with divisions at one of the hospitals with which DAE co-operates. The costs of this computer are not included in this report.
   The space requirements are not proportional to the number of employees. This result may be explained partly by the fact that DAE requires extensive laboratories while at DSM the scientists to a great extent work in laboratories and at DTP the scientists mostly work in libraries and at home.

9. Table 9. Project costs are smaller at DAE and DTP; at DAE due to small projects and at DTP due to the theoretical nature of research. Consequently the man-days are cheapest at DTP.

10. Table 10. Costs of administration decrease with the size of the division. DAE and DTP display high administrative costs due to high load of undergraduate education.
    DAE and DTP both have division libraries while DSM makes use of central libraries. This possibly explains the difference in relative library costs.

11. Table 12. At DAE and DSM research costs occupy a higher portion of the total budget than at DTP. At DAE and DSM this result is related to the financing structure. Most of the research resources come from research councils.

Summary

Summing up the results of the pilot study we arrive at a number of parameters that characterize a division for higher education and research.

1. The nature of the research. Primarily we distinguish between theoretical and experimental (applied) research. The second type is very differentiated and there is reason to divide it into more specific types of research.

2. The structure of the staff. Even though the holders of office do not strictly follow the existing rules for the office, the structure of the staff plays an important role regarding the allocation of resources and regarding the costs of the programmes.

3. The contribution from the research councils considerably affects the organization of research work. The research councils allocate money to projects and require current reports of the outcome of these projects. Thus the partition of research work into projects is more accentuated at divisions with a high portion of resources from the research councils. One may assume that these projects in general are smaller (cf. DAE) since many small projects presumably give more resources than one big project.
   Since we have not made use of any output measures of research in this pilot study it has not been possible to test the value of the "project idea" compared to what is popularly called "free research". However, current discussions and seminars on research administration indicate that a well planned project with specified points of reporting and with well defined goals is probably more successful than research having no definite aims. An important factor is the motivation that the scientist has to continue his project. Experience shows that current reporting and the fulfilment of subgoals favour this motivation.

4. The teaching load has a considerable impact on the work at the division. High teaching load pulls the scientists from research and at the same time it causes current interruptions in the regular research work. Since successful research requires a high degree of concentration this is a serious problem that has to be taken care of perhaps by separating the undergraduate education from research and graduate training at the divisional level.

# Chapter 5

## OUTPUT MEASURES OF GRADUATE TRAINING AND RESEARCH

The project description (Chapter 1) points out the problem of developing output measures of graduate training and research. The original aim was to develop such measures in the pilot study. However, lack of time and useful ideas have forced us to confine this part of the report to a general discussion of possible output measures.

The following aspects of output measures emanate from interviews with university officials, participation in seminars on research administration and a study of current reports on these matters.

The output measures of graduate training do not in principle differ from those of undergraduate education which have been treated in previous reports. Thus the output of graduate training can be characterized by :

1. received course credits;
2. concluded theses;
3. passed doctorate exams.

The problem of testing these measures is primarily one of registrating results. This has yet not been accomplished and therefore we shall not at this point go any further into the measures of graduate training but refer to earlier reports published by the PPBS group in Gothenburg.

As is pointed out in Chapter 2 all decision and planning activities require information about the programme. From this point of view output measures have to be related to the goals of the programme. This survey stresses the PPBS requirement that output measures should be related to costs and goals. This does not necessarily mean that all goals have to be operational and that all output measures have to be quantitative. Also general goals and qualitative descriptions of the programme constitute a good basis for decision and planning - and a better basis than no information at all.

## 1. WHY RESEARCH REPORTS ?

Recent development in science and technology offers a number of reasons for having a functioning system of reporting results of scientific and technical research.

1. Research is considered to be of primary importance to the development of our society and our civilization.
2. From the importance of research it follows that having the control of research proceedings means control of the development of society. Thus there is a power argument for having the control of research output.
3. Limited resources are available for R&D. Economic and other material resources do not provide for an infinite research programme. Further there is a limitation with respect to personnel, especially personnel having enough knowledge and experience for launching successful research. From these limitations follow that costs of research continually increase.
4. Scientists experience motivation as they have to produce concrete results according to a time schedule. One may assume that this kind of pressure in a positive way affects the productivity of research.
5. To establish priorities among different fields of research and projects requires a thorough knowledge of research results, scientist's capacity, costs and productivity.

Programme Budgeting is primarily concerned by arguments (3) through (5). In order to get as much as possible out of limited resources for R&D we have to make an optimal allocation of available resources to projects considered as "valuable". Further we have to look for means of improving the productivity of research,which means improving the conditions of creativity.

## 2. A HIERARCHY OF RESEARCH GOALS

Goals of R&D may be thought of as grouped into hierarchical levels representing different degrees of generality. Thus the goals on the highest level may be interpreted and reformulated into goals on the level below, etc. Finally we reach the performance level where the actual research work takes place. We shall distinguish between the following three levels of goals.

1. *Internal goals* are goals for the performance level which are generated within the scientific field itself. These goals constitute the *basis* for selecting the methods to be used for deciding which scientist(s) is (are) most fit for the project and for setting the limitations of the research projects.
2. *External goals* are related to the value of the research results of one scientific field compared to results of other scientific fields within the same science.
3. *Ultimate goals* constitute the basis for setting the total research potential and for relating the volume of different sciences to each other. These goals are concerned with the aims of mankind, with cultural and social goods.

As a matter of fact there should be some kind of output measure to test the goal fulfilment of each of these groups of goals. In the following section we shall present some possible measures for this purpose.

## 3. EXAMPLES OF OUTPUT MEASURES OF R & D

1. The most apparent and simple methods of evaluating research performances is to count the *number of articles* and reports that have been published by each scientist or research group. This method of Shockley does not take into account any evaluation of the publications except for judgements that may be made by the editors of the periodicals.
2. *The method of Westbrook* represents an improved method of counting publications. Only such publications to which other authors have made references are considered. In this case references made by colleagues at the same laboratory must be excluded. However, since the network of contacts between scientists within a scientific field usually is well developed this is still not a good method. Further there is a considerable time lag between the publishing of the original report and the point at which it is possible to count the number of references with any accuracy.
3. The *number of patents* granted is another possible measure. However, it is not always appropriate to patent a research result, especially when it is of no immediate commercial interest. At divisions of the University of Technology in Stockholm there turned out to be 0.05 applications for patents per man-day compared to 0.7 applications/year for Sweden as a whole.
4. Regarding technical research the possibilities of further development of a research result and the financial profits that can be made

due to this development seem to be appropriate measures. One advantage of this measure is that it can be represented in calculated terms of economy. The problem appears when we recognize that only very few projects are directly responsible for economic growth. The others form the background knowledge.

5. Another method of expressing the relationship between economic growth and R&D is the technological factor. Through efforts it is possible to reach a high correlation between technological factor and the number of man years spent on R&D. This method may be valuable when comparing technical fields to each other but is certainly useless with respect to individual projects at the performance level.
6. The degree of goal fulfilment is a general measure of output. However, this measure may be adapted to a system of research planning in which every research project is supposed to have a detailed plan with well specified points of documentation and with fixed economic limits for each interval of the project. Provided the goals can be followed up it is possible to relate the degree of goal fulfilment to this project plan. Of course this method is only current follow-up at the performance level. Since this measure of goal fulfilment does not involve "higher" goals it should not be used at the higher levels of decision.
7. The traditional method of measuring output is to measure input to the research process. Since the primary goal of the PPBS is to construct an output-oriented budget system this method is completely uninteresting. It is based on the assumtion that there is correlation between input and output of research, an assumption which in many cases turns out to be false.

## 4. DISCUSSION

The methods presented in the preceeding paragraph apply to different levels of one goal hierarchy.

Every official goal and the corresponding output measure has an important impact upon the way in which research at the performance level functions. Thus, if for instance the research councils in Sweden would use the number of articles as a basis for allocating resources, the production of more or less worthless publications would increase considerably. To use goal fulfilment as a primary output measure probably makes the scientists conclude their projects before the problems are really solved. It is obviously important to relate the output measures to the goals in such a way that the scientists finally aim at the goals of the higher levels.

Table 6.1

THE RELATIONSHIP BETWEEN LEVELS, GOALS AND MEASURES ARE GIVEN IN THE FOLLOWING TABLE

| Level | Goals | Output measure |
|---|---|---|
| Internal | To produce original results | Number of patents (3) |
| | To account for research performances | Number of articles and reports (1) |
| | To follow given project plans | Goal fulfilment (6) |
| External | To contribute to technological development | Method of Westbrook (2) |
| | To contribute to economic growth | Technological factor (5)<br>Financial profits (4) |
| Ultimate | To contribute to the development of mankind | Happiness ?! |

No single output measure is enough for judging the value of the research performed. Many different criteria have to be applied for developing a fair picture of the performances. The Medical Research Council (MRC) since 1965 makes current use of a system of priority values (Table 6.2)

Table 6.2

PRIORITY VALUES USED BY THE MEDICAL RESEARCH COUNCIL

| Value | Problem | Procedure | Competence of investigator | Scientific report |
|---|---|---|---|---|
| 4 | Original | Original | Excellent | --- |
| 3 | Very interesting | Very good | Very high | Excellent |
| 2 | Interesting | Good | High | Very good |
| 1 | Doubtful | Doubtful | Doubtful | Good |
| 0 | Not acceptable | Not acceptable | Not acceptable | Doubtful or not acceptable |

when analyzing applications for project grants. Every member of the council gives his judgement of an application in terms of these values. When judging scientific reports, the number 3 shall indicate that the results constitute a new part of the research frontier, the number 2 that the quality of the results is very good, 1 that it is good. When the quality of the results is considered doubtful or unacceptable, the number 0 is given. Corresponding rules apply for the other values. The numbers given by the numbers of the councils are summarized to give mean values for each criteria. These mean values are then used as one parameter of decision in the final meeting.

In order to give a correct judgement the person who analyzes the results of a research project with respect to internal and external goals must possess a considerable knowledge of the technical fields in question. He must research experience himself and be conscious of the problems involved in current research. Thus methods of evaluating output is no substitute for expert decision-makers (cf. Chapter 2).

Looking at PPBS on the university level we are not in the position to make any final conclusions. Obviously the actual goals of the university must be officially set before adequate measures can be applied. If the goal of the university is to produce research results with great speed but less quality the method of measuring goal fulfilment is probably a good one.

If the university in the first place is to spread information to the scientific world and to the public about current research, the method of Shockley applies. Thus by formulating goals of activities it is possible to receive a basis for developing output measures to be used in the budget procedure.

Chapter 7

# THE PPBS MODEL FOR GRADUATE TRAINING AND RESEARCH AT CHALMERS

## 1. INTRODUCTION

In this chapter we are going to propose a PPBS model for Graduate Training and Research at CTH. The PPBS (Planning, Programming and Budgeting System) consists of several subsystems, such as :

- The Programme and Goal System
- The Financing System
- The Organizational System
- The Planning System
- The Information System.

The subsystems of the PPBS-model are presented below. In connection with the Planning System, the use of output measures in the decision-making is discussed.

Although the objective of this study is to sketch a model of PPBS at the university level, most of the questions and parts of the model are identical for the national level. If we in this study are suggesting a PPBS model for the university we must thus make some assumptions and proposals concerning the environment of the university and how the primary supporting agencies of the national level are going to behave in a future PPBS.

In the model we are going to discuss different alternatives of organization and behaviour of the national level, propose one of the alternatives for the model and finally evaluate how this alternative could be realized.

## 2. GOALS AND PROGRAMMES

### A general principle to create the programme according to the goals in the area of higher education and research

As said in Chapter 2 point 8, demand from the private sector of the economy formulates the goals of the university. These goals should then be transformed into programmes of performance of the public administration. There are many ways to form and classify the public activities in programmes. Usually the formulated goals, if there are any, will have the greatest impact when forming the programmes, but also practical circumstances and the present organizational structure will influence the classification of public programmes. We shall here show why it is appropriate to formulate three programmes in the area of higher education and research, namely :

Undergraduate Education;
Graduate Training;
Research.

Our discussion can be followed in Figure 7.1. The economy could be divided into different sectors, each of which represents principal areas of activity of society. Each sector has a demand of public support of various types. In this study we divided the demand into :

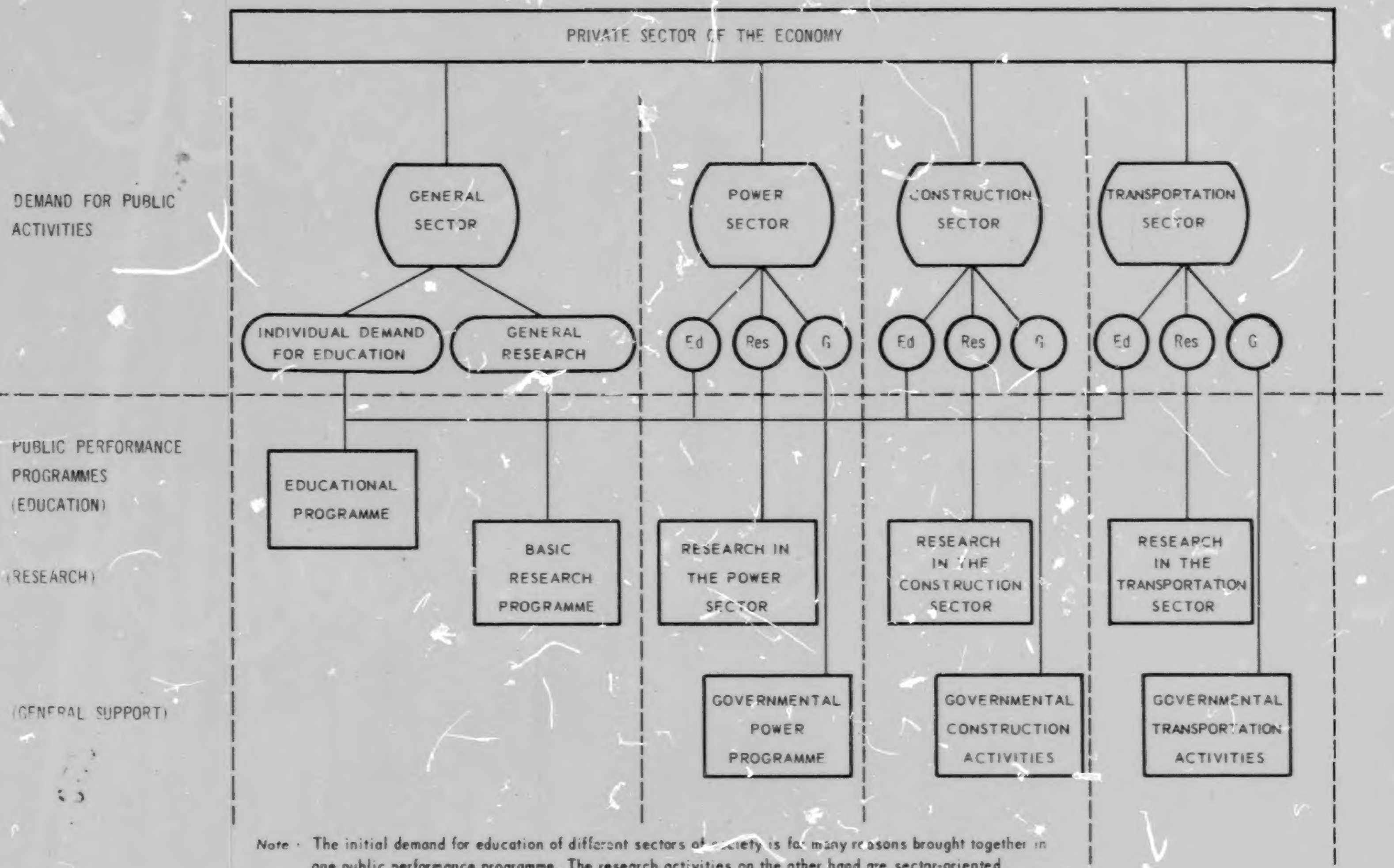
Education;
Research and Development;
General support.

As an example let us take the transportation sector. This area of the economy requires at the outset general support in public transportation activities such as public railways, roads, airways, transportation laws, etc. Other than the above the Government is in charge of the management of a great deal of the research and development activities in the sector. This research is performed in state laboratories, universities and in private firms with governmental support.

Many occupations in the sector claim for more or less education. Some of these demands are supplied by the public sector through secondary or higher education.

There is, however, a significant difference when the "general support" and research on one hand, and education on the other hand are performed by the public administration. The direct governmental support as well as the research and development are generally organized within the sector itself and managed by the public authorities of the sector in question. The demand

Figure 7.1


PRIVATE SECTOR OF THE ECONOMY
DEMAND FOR PUBLIC ACTIVITIES
PUBLIC PERFORMANCE PROGRAMMES (EDUCATION)
(RESEARCH)
(GENERAL SUPPORT)
GENERAL SECTOR
POWER SECTOR
CONSTRUCTION SECTOR
TRANSPORTATION SECTOR
INDIVIDUAL DEMAND FOR EDUCATION
GENERAL RESEARCH
Ed
Res
G
Ed
Res
G
Ed
Res
G
EDUCATIONAL PROGRAMME
BASIC RESEARCH PROGRAMME
RESEARCH IN THE POWER SECTOR
RESEARCH IN THE CONSTRUCTION SECTOR
RESEARCH IN THE TRANSPORTATION SECTOR
GOVERNMENTAL POWER PROGRAMME
GOVERNMENTAL CONSTRUCTION ACTIVITIES
GOVERNMENTAL TRANSPORTATION ACTIVITIES

*Note* · The initial demand for education of different sectors of society is for many reasons brought together in one public performance programme. The research activities on the other hand are sector-oriented.

for education of a special sector of the economy is however not usually performed within the sector itself even if there are examples of the opposite. Most of the educational activities are handled by certain educational authorities and institutions. The reason why education is brought together and performed in an integrated way is partly due to practical reasons such as economies of scale, possibilities of high level of integration between different branches of education, need for generally accepted rules for different branches of study, but there is also a high demand for "general" and non-sector education.

The above-mentioned facts are the main reasons why we have chosen to let all educational activities be regarded as a main programme of public administration and that the research is divided into research for each sector. This basic consideration influences the total organization of education and research in our model. In many sectors, especially in the area of technology, there is, however, a strong link between the demand sector and the corresponding educational activities in the technical universities. This need for co-operation is met at the local as well as at the national level by the participation of representatives of the sector in various committees for sector-oriented education.

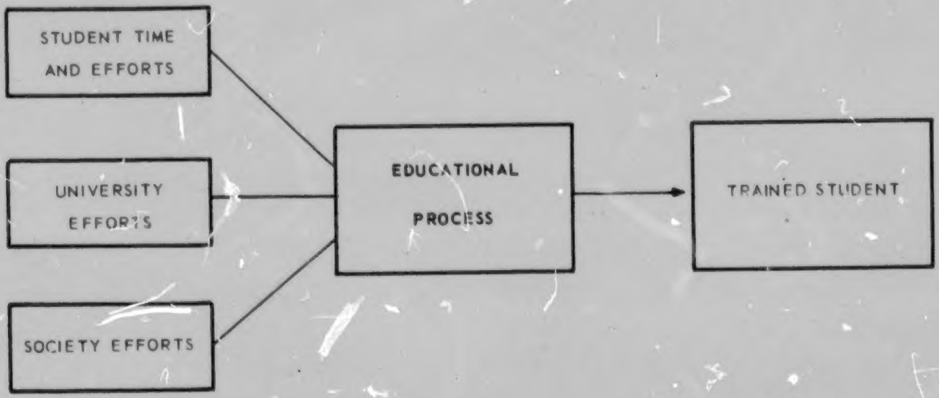
## A discussion concerning the goals of the programmes

Before we present the final arguments for the programme structure, there is a need for a resumé and discussion around the goals of the actual programmes.

### a) Undergraduate Education

The goals of the undergraduate education of a university of technology are, as pointed out above, strongly related to various sectors of technology of the society. The part of the demand for higher education in the faculties of technology that could be considered as "general education" or for "individual" purposes only (students who do not intend to use their education for a future occupation in the field), is less and not so common as in, for example, the faculties of arts. Most civil engineers are absorbed by industry, many of them in a sector corresponding to their branch of study. Some of the students remain in the university system as teachers and scientists and a smaller part switches to other areas of occupation.

A particularity of the educational activity is that the student is a part of the productive system, roughly shown as :



When dealing with educational matters and goals and objectives for education it is very important to distinguish between the goals of the total educational system and the objective of the university. The university only controls some input-variables of the total educational system and will, when setting objectives, try to optimize the university efforts, of course, with the close influence from external student/society variables. There is, however, an obvious risk of sub-optimalization in this system in that internal university objectives would dominate over student and society goals.

One of the sub-goals of the educational performance mentioned before is that the individual student should have possibilities of choosing among alternative lines of education in a succesive way. This will lead to an educational organization with strongly integrated subjects - one of the reasons why education is performed by broad units such as universities.

b) Graduate Training

In Sweden the corresponding expression to Graduate Training can be translated as "education of researchers". This expression is not adequate, as the education we are talking about serves both as education for occupations for industry and as preparation for scientific/academic activity. In some subjects Graduate Training serves as a higher education for a common occupation. Examples of this could be medical education and some specialized technical fields of education. In basic science, however, a great deal of the demand for Graduate Training arises from the research organization itself. A research organization normally needs to replace retiring scientists by recruiting new researchers. We therefore could express the following demand as :

- Graduate Training for non-scientific activities (teachers, doctors, technicians);
- Graduate Training of researcher for industry;
- Graduate Training for university research organization (internal research demand).

The first category of demand should, according to our discussion in section (a) above, be supported by the educational authorities. In principle, so should the second category.

The third category, however, is an internal demand from the research organization and could be regarded as internal education. The size of this demand is probably related to the size of the university research of the sector. The third category should consequently be regulated by the research authorities.

There is an other point of view that must be focused upon when classifying the programmes and this is the performance of Graduate Training. It could be divided in two parts, namely :

- Graduate courses;
- Research activity leading to thesis work.

Graduate courses are directly related to the fulfilment of the goals of Graduate Training. The research activities by the graduate student are, however, at the same time an essential part in Graduate Training and a part of the research activities of a division.

Here, we have a situation of conflicting goals. We have to make one of the goals dominate the other and set a restriction when performing the dominating goal. In this case we chose to let the research activities by a graduate student be covered by a research programme. The restriction we add to the research programmes of the university is that graduate students should, if possible, participate in the performance of the research of a division.

We consider the research activities of a graduate student to be a part of the research programme, and the graduate courses, the remaining activity of the graduate training programme, could be described as follows :

1. Research activity by graduate students needs appropriate research activities within the university. Such research activities are the research projects of the divisions. The research projects need project leaders, assistants, current expenditure, equipment, technicians, space, etc. Normally all these items are supplied by the

research authorities. Graduate students normally participate as assistants in these projects and it would be wrong if the need for appropriate research projects for the graduate students should be the dominating variable in the allocation of the resources to the research programmes. Naturally the needs within the research programmes shall determine the size of the research activities, including staff posts suitable for graduate students.

2. All three categories of graduate students (see above) are normally engaged as assistants in the research organization. If there is an over-demand for graduate students, special scholarships could to a certain extent be available as a substitute to the staff posts as assistants in the projects. In some cases the best solution could be a restricted admission to graduate training, namely when neither the research nor the educational authorities are interested in an "over-production" of graduate students in a certain subject.

   If the educational authorities have a demand for graduate education (categories one and two) in a subject, special arrangements must be made, with the support from the educational authorities to have graduate courses and to give research experience to the graduate students (not necessarily by research activities within the university, but also through co-operation with industry, etc.).

3. The institutional questions of graduate training (curricula, admission rules) as well as the shape of the graduate courses and the scholarships for graduate training are, at both the national and university levels, handled by responsible programme units which are separate from the research programme and more connected to the undergraduate programme. To give these programme units a well-formulated responsibility and objective, a clear definition of the programme must be made.

Figure 7.2 shows the classification of the programmes and the programme elements and which cost components the programmes should include.

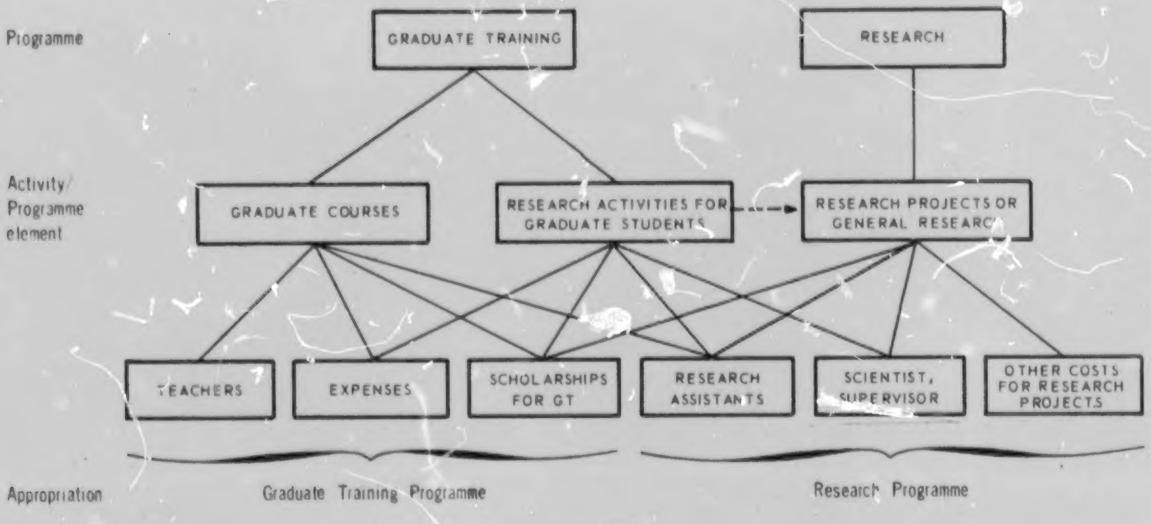
Research

The goals of research follow the sectors of the economy as mentioned above in section 2. Some basic research is of course difficult to refer to a special sector of technology and must consequently be classed as "general research".

Public research is performed in a sector by several public institutions such as universities and state laboratories or by private societies with

Figure 7.2

RELATION BETWEEN PROGRAMME, PROGRAMME ELEMENTS, COST COMPONENTS AND APPROPRIATIONS FOR THE PROGRAMMES


Programme
GRADUATE TRAINING
RESEARCH
Activity/ Programme element
GRADUATE COURSES
RESEARCH ACTIVITIES FOR GRADUATE STUDENTS
RESEARCH PROJECTS OR GENERAL RESEARCH
TEACHERS
EXPENSES
SCHOLARSHIPS FOR GT
RESEARCH ASSISTANTS
SCIENTIST, SUPERVISOR
OTHER COSTS FOR RESEARCH PROJECTS
Appropriation
Graduate Training Programme
Research Programme

governmental support. From a governmental point of view, all public research of an area or sector must have the same general objective. Looking at the present situation the financing structure is as follows :

Figure 7.3

FINANCING STRUCTURE VERSUS SECTOR OF RESEARCH

National Board of Building

Equipment Board

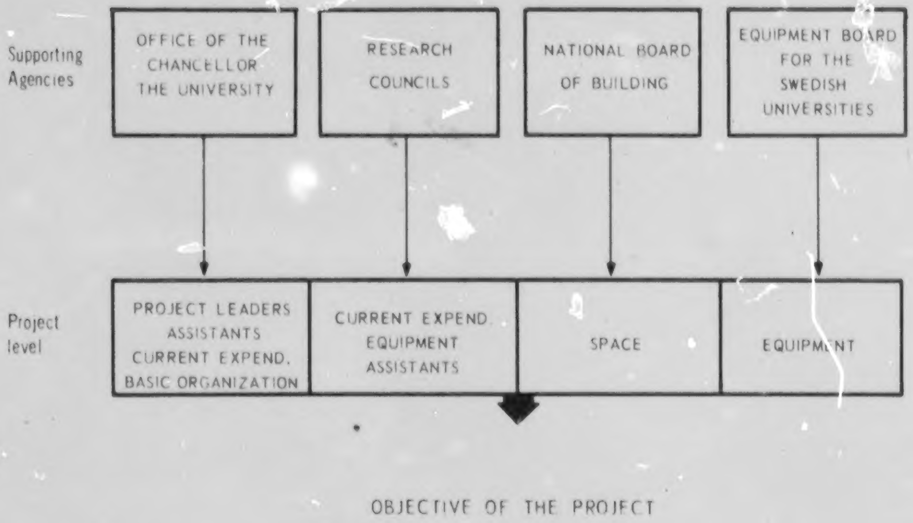
Office of the Chancellor

| | | | |
|---|---|---|---|
| Research Council A | Research Council B | Research Council C | Research Council D |
| Sector A | Sector B | Sector C | Sector D |

Some of the support is sector-oriented, namely that of the Research Councils. The support from the Office of the Chancellor, the National Board of Building and the Equipment Board for the Swedish Universities is related to the financing of the educational activities within the universities.

The aim of our pilot study was to examine how these financial inputs are organized within the divisional performance of the Research and Graduate Training. In this study we found that different financial sources from different supporting agencies collaborated in the performance of the research projects. This is shown below.

FINANCIAL SOURCES OF A RESEARCH PROJECT


Supporting Agencies
OFFICE OF THE CHANCELLOR THE UNIVERSITY
RESEARCH COUNCILS
NATIONAL BOARD OF BUILDING
EQUIPMENT BOARD FOR THE SWEDISH UNIVERSITIES
Project level
PROJECT LEADERS ASSISTANTS CURRENT EXPEND. BASIC ORGANIZATION
CURRENT EXPEND. EQUIPMENT ASSISTANTS
SPACE
EQUIPMENT
OBJECTIVE OF THE PROJECT

The project concept is mainly used in applied research. In basic research the expression field of research is more convenient. Similar to both expressions is that the objective of the project or the research field is unique and not correlated to the different financial sources. According to the description of goals, objectives and other instructions regarding research activities within the universities no separate objectives are to be found explicitly related to the different financial sources.

Thus, for each "sector of research" of the university, one research programme covering a set of projects is to be established. How the classification of these sectors or programmes shall be made must depend on the following circumstances :

- Possibility to formulate a programme of research by sector of research or technology;
- Possibility to make clear distinctions between the different sectors or programmes;
- Organization of the research at the national level as well as at the local performance level.

When we look at the present financing structure we notice that there is an organized and clear pattern regarding the financial support the Research Councils give to the University.

From what is shown in Table 3(e) of Appendix I, one can conclude that one field of research, often corresponding to a department, is supported by one Research Council. Thus we can roughly connect departments and main supporting Research Councils as follows.

| Department/Part of Department | The main supporting Research Council |
|---|---|
| Dept. of Mathematics | None |
| Dept. of Physics | Natural Science Research Council (NRC)<br>Atomic Research Council (ARC) |
| Dept. of Mechanical Engineering | Board for Technological Development(BTD) |
| Dept. of Electrical Engineering | Board for Technological Development(BTD) |
| Dept. of Civil Engineering | Council for Building Research (BRC) |
| Dept. of Chemistry (basic sciences) | Natural Science Research Council (NRC) |
| Dept. of Chemical Engineering | Board of Technological Development (BTD) |
| Dept. of Architecture | Council for Building Research (BRC) |

The table above only shows the financial relations between the departments and the Research Councils. It should be emphasized that there can be other relations in research activities between the departments and the Research Councils, such as co-operation and exchange of information, without any financial links. When forming fields of research, the structure of the financial support, however, shows that it would be possible to make the fields of research in most cases correspond to each department. Some departments must perhaps be sub-divided into more than one field of research, the area of the departments must in some cases be adjusted and in some cases "overlapping" fields of research would have to be established. One can, however, say that the department/field of research relation is a good start for the classification of the research programmes.

Conclusions regarding the goals and programme structures

As a summary of this section we can formulate the proposed programme structure of the University.

According to the discussion above we have defined a separate programme for the Graduate Training. The research activities will be formulated in programmes corresponding to the Fields of Research.

Table 7.1

THE PROGRAMME STRUCTURE

| Programme | Sub-programme | Programme element | Programme Structure |
|---|---|---|---|
| 1 | | | UNDERGRADUATE ENGINEERING EDUCATION |
| | 1-6 | | Schools (e.g. Mechanical Engineering) |
| | | 1- | Courses |
| 2 | | | UNDERGRADUATE EDUCATION FOR THE FACULTIES OF SCIENCE AND SOCIAL SCIENCE |
| | 1-9 | | Instruction - disciplines (e.g. Mathematics) |
| | | 1- | Courses |
| 3 | | | GRADUATE TRAINING |
| | (1-7) | | (Graduate Training in different Fields of Research) |
| | | 1- | Courses |
| 4 | | | RESEARCH |
| | 1-7 | | Research in different Fields of Research |
| | | 1- | Research projects |
| 5 | | | EXTERNAL SERVICES |
| | 1 | | Building maintenance service |
| | 2 | | Library services |

## 3. FINANCING SYSTEM

### General

According to the basic concept, it was stated that each programme should correspond to an appropriation. We have in the preceding section formulated the following principal programmes :

1. Undergraduate Education programme
2. Graduate Training programme
3. Research programmes.

Firstly the different programme appropriations are going to be specified - which types of costs they cover for each programme. Secondly three alternative financing strategies are going to be discussed.

### The content of the programme appropriations

Table 7.2

COSTS MOSTLY COVERED BY PROGRAMME APPROPRIATIONS

| Type of costs | Undergraduate Education | Graduate | Research |
|---|---|---|---|
| Salaries to teachers | X | X | X |
| " " asst. teachers | X | | X |
| " " non-academics | X | X | X |
| Computer time | X | | X |
| Material, current expenditures | X | X | X |
| Salaries to scientists | | | X |
| " " research assts. | | | X |
| Scholarships | | X | |
| Gen. administration | X | X | X |
| Investment of equipment | X | (X) | X |
| Renting cost for the buildings | X | X | X |

The Undergraduate programme and the Research programmes will include most of the existing costs. The financing of the investment of equipment should also be granted by these appropriations. Buildings will, however, be rented from the National Board of Building and the cost will be included in the programme appropriations.

The appropriations cannot be exceeded. Extra costs are saved for the following fiscal year. In the programme plans and budget request, the current expenditures should be presented separately from the investments. In the yearly granting, however, a lump sum for each programme should be given, including estimated cost for investments. We shall come back to this when presenting the planning procedures.

The appropriation for the Graduate Training programme will, according to the discussion in point (b) above, only cover costs for graduate courses, examination costs and scholarships, i.e. marginal costs for the Graduate Training.

## Supporting national agencies

We have now defined three separate programmes which should be financed through programme appropriations. Such a programme appropriation should be financed if possible by one national agency. This is the case, in principle, for the undergraduate programme which is entirely financed by the Office of the Chancellor.

With our definition of the Graduate Training programme and what costs it should include and the nature of the programme (see (b) above) we have come to the conclusion that these defined Graduate Training activities should be supported by the educational authority, the Office of the Chancellor.

Regarding the Research programmes we find that several national agencies are sponsoring these programmes. It is not our task to reform the national research policy in this project, but here we have an institutional fact, which according to the philosophy of PPBS is a big obstacle for a programme budgeting behaviour in the research programmes. We shall, therefore, reflect somewhat on this and design alternative strategies on how the financing of the research programmes of the university should be performed. The alternative chosen will of course influence the design of the PB-model and therefore the question is of greatest importance.

## Alternative strategies for the financing of the research programmes

1. All research activities at the universities are financed by the educational authorities (Office of the Chancellor).
2. Total basic organization for the research is financed by educational authorities. Specific project costs are financed by research authorities (Research Councils). (This is the present situation).
3. All public research activities at the universities (and other research organizations) are financed by research authorities (Research Councils or similar agencies).

The first alternative where the total public research support to universities is handled by one central research and education authority will, according to our opinion, lead to a too centralized and "impossible" situation. In general, the attempts to centralize the total public research "horizontally" to one department of the Government or a special research agency have not been successful. Referring to Figure 7.3 we find that the need for and the performance of research for each sector of society is so directly tied to the sector itself that it is almost impossible to build the resource allocation on one central agency which is to evaluate the needs for research of different sectors, allocate resources and evaluate the results.

The second alternative suggests that the present situation remains. The present configuration has been described in the preceding chapters and the relation between the financial structure and the goals of the programmes has also been discussed in section on Research above.

This alternative does not fit some of the basic concepts of PPBS, namely :

a) Each programme should be related to one financial source or appropriation.
b) Each programme corresponds to a programme-responsible unit at each level (even at the national level).

There is a dilemma on how to manage the financial allocation of the resources for the research supported by the educational authorities to the universities. As said before, these resources have been calculated and allocated in direct proportion to the educational resources. As shown in section 2 above we are however convinced that this principle is not the best one in the long run, due to the fact that the need for undergraduate education, graduate training and research of a sector of society is not automatically in a given proportion to each other. The lack of an objective for the allocation of these university resources for research will lead to a high degree of sub-optimalization in the management of the universities.

The third solution is the most appropriate one according to the principle of PPBS. All relevant requirements for programme budgeting are fulfilled. It has however a great lack - it claims for a radical change of the financing structure and the organization of the research questions at the national level. In this study we are not going to discuss the possibility of changing the present organization at the national level. However, if we should design an appropriate model for PPBS for the university it would seem most adequate to take the third alternative as the base. The reason is quite clear and can be found above in the analysis of the second alternative - a programme budgeting model is hard to build on the second alternative. Section 8 discusses the possibilities of realizing the proposed model and the adjustments necessary due to the institutional factors.

Summary of the proposed financing system for the model

The financing of the total university activities is proposed to be made by programme appropriations. The programme appropriations will follow the programme structure (see Table 7.1) and be granted by the programme responsible agencies at the national level (see Table 7.3). The programme appropriations will furthermore contain all relevant costs and will in general be granted by the national agencies for one or several fiscal years. It should also be possible to save unused resources for the following fiscal year, for a better economic distribution.

| Programme | Appropriation | Granted by/Programme responsible agency |
|---|---|---|
| 1. Undergraduate Engineering Education | Undergraduate Engineering Education | The Office of the Chancellor |
| 2. Undergraduate Education National Sciences | Undergraduate Education National Sciences | The Office of the Chancellor |
| 3. Graduate Training | Support of Graduate Training | The Office of the Chancellor |
| 4(a) Research Field A | Research Field A | National research agency in field A (Research Council) |
| 4(b) Research Field B | Research Field B | National research agency in field B (Research Council) |
| etc. | etc. | |

## 4. THE ORGANIZATION OF THE DECISION UNITS

The organization consists in our terminology of two types of units :

i) Programme units (responsible for the programmes);
ii) Production units (responsible for the production).

The difference between the objective of the programme-responsible units and the production or the administrative units could be formulated as follows :

> The objective for a programme-responsible unit is to optimize the performance within the corresponding programme. (Maximize the programme output and minimize the programme costs).
>
> The objective for a production unit is to optimize the use of productive resources (staff, space, physical plant, etc.) for different programmes so that full capacity and high productivity is maintained. The production units will furthermore try to achieve some "optimum mixture" of programmes.

### The Programme Units

According to the basic concepts of PPBS (see Chapter 2, section 8), we stressed that each programme should have a programme-responsible unit at each level of the programme and organization. The following table and figure show the programme-responsible units proposed for, and the planning procedure of, the research programme.

Table 7.3

THE PROPOSED PROGRAMME-RESPONSIBLE UNITS FOR THE RESEARCH PROGRAMME

| | Programme level | Responsible organizational unit |
|---|---|---|
| Institutional level | Project | Project group or project leader |
| | Field of Research | Committee of Research |
| | (All fields of Research within the | (Central committee of Research and the Board of the University) |
| National level | Field of Research (national level) | Agency responsible for the research field<br>(Research councils or the similar agencies) |

Figure 7.4

THE PLANNING PROCEDURE OF THE RESEARCH PROGRAMME IN CHRONOLOGICAL ORDER

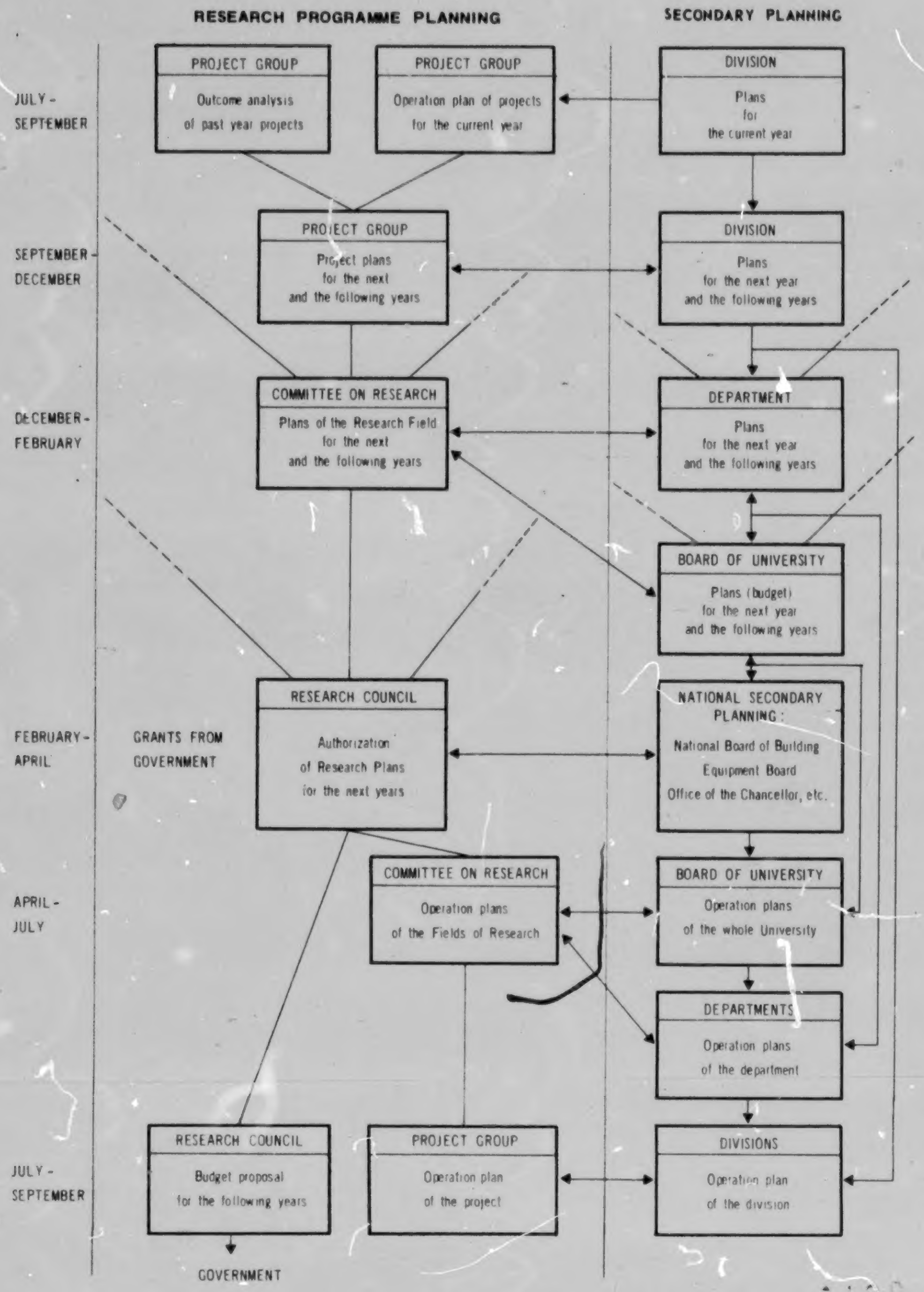

RESEARCH PROGRAMME PLANNING
SECONDARY PLANNING
JULY - SEPTEMBER
PROJECT GROUP
Outcome analysis of past year projects
PROJECT GROUP
Operation plan of projects for the current year
DIVISION
Plans for the current year
SEPTEMBER - DECEMBER
PROJECT GROUP
Project plans for the next and the following years
DIVISION
Plans for the next year and the following years
DECEMBER - FEBRUARY
COMMITTEE ON RESEARCH
Plans of the Research Field for the next and the following years
DEPARTMENT
Plans for the next year and the following years
BOARD OF UNIVERSITY
Plans (budget) for the next year and the following years
FEBRUARY - APRIL
GRANTS FROM GOVERNMENT
RESEARCH COUNCIL
Authorization of Research Plans for the next years
NATIONAL SECONDARY PLANNING:
National Board of Building
Equipment Board
Office of the Chancellor, etc.
APRIL - JULY
COMMITTEE ON RESEARCH
Operation plans of the Fields of Research
BOARD OF UNIVERSITY
Operation plans of the whole University
DEPARTMENTS
Operation plans of the department
JULY - SEPTEMBER
RESEARCH COUNCIL
Budget proposal for the following years
PROJECT GROUP
Operation plan of the project
DIVISIONS
Operation plan of the division
GOVERNMENT

Table 7.4

THE PROGRAMME-RESPONSIBLE UNITS FOR THE GRADUATE TRAINING PROGRAMME

| | Programme level | Responsible organizational unit |
|---|---|---|
| Institutional level | Graduate Training activities within the subject (Courses examination, thesis work) | Supervisors of the subject |
| | Graduate Training programme | Central Committee for Graduate Training |
| National level | Graduate Training in Technology | Office of the Chancellor of the Swedish Universities |

See also Figure 7.5

## The Production Units

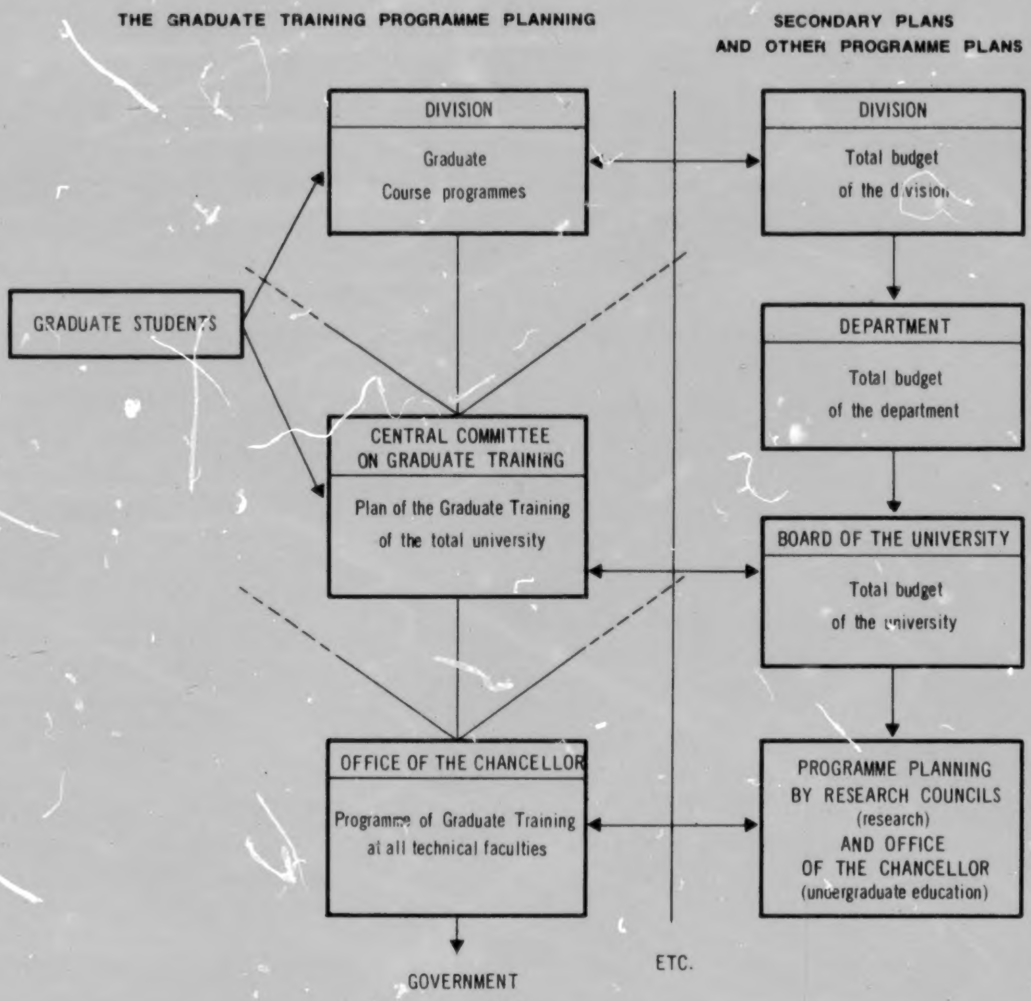
Each programme or programme part is performed within a production unit. The production units are the organizational units where the real activities such as teaching, research, laboratory work, administration, etc. take place.

Table 7.5

THE DIFFERENT LEVELS OF PRODUCTION UNITS WITHIN THE UNIVERSITY

| | Programmes, Subprogramme, etc. | Productive unit |
|---|---|---|
| Institutional level | Courses<br>Graduate Training activities<br>Research projects | Divisions<br>(Board of the Division) |
| | Undergraduate School programme<br>Graduate School programme<br>Field of Research(s) | Department<br>(Board of the Department) |
| | Undergraduate Engineering programme | University<br>(Board of the University) |
| | Graduate Training programme | |
| | Research programmes | |
| National level | Education and Research at the Swedish universities | Office of the Chancellor of the Swedish Universities (as administrative and controlling agency) |

Figure 7.5


THE GRADUATE TRAINING PROGRAMME PLANNING
SECONDARY PLANS AND OTHER PROGRAMME PLANS
DIVISION
Graduate Course programmes
GRADUATE STUDENTS
CENTRAL COMMITTEE ON GRADUATE TRAINING
Plan of the Graduate Training of the total university
OFFICE OF THE CHANCELLOR
Programme of Graduate Training at all technical faculties
GOVERNMENT
ETC.
DIVISION
Total budget of the division
DEPARTMENT
Total budget of the department
BOARD OF THE UNIVERSITY
Total budget of the university
PROGRAMME PLANNING BY RESEARCH COUNCILS (research) AND OFFICE OF THE CHANCELLOR (undergraduate education)

## The relation between the Programme units and Production units

In Figure 7.6 the total organization of the university is shown. For each of the programmes the programme-responsible units for each level are presented.

In the Undergraduate programme, there is at present an established programme organization, at all three levels. In the Graduate Training programme, however, there is a Central Committee of Graduate Training. No corresponding programme units at the school or departmental level have so far been established, due to the fact that the Graduate programmes are performed entirely at the divisional level. The Central Committee of Graduate Training will serve as a co-ordinator directly to the divisions.

In the Research programme we find that the most appropriate programme units for research decisions are the Committees of Research, corresponding to the fields of Research and quite often to the department. The departments are mainly established as units in which research disciplines and research methodology are similar. However, we also consider that a distinction between the department and a separate Committee of Research could be useful in many respects. For example, a Committee of Research could play a more independent role in policy questions, resource allocations, etc., without too many departmental influences concerning "non-research questions". The Committees of Research will deal directly with different project groups.

At central university level we have the Central Committee of Research whose purpose it is to advice the Board of the University on policy questions within the research programme.

The production units are still the divisions and the departments. They have the objective to co-ordinate education, graduate training, research activities with staff structure, financial questions, space and equipment requirements, etc., at each level.

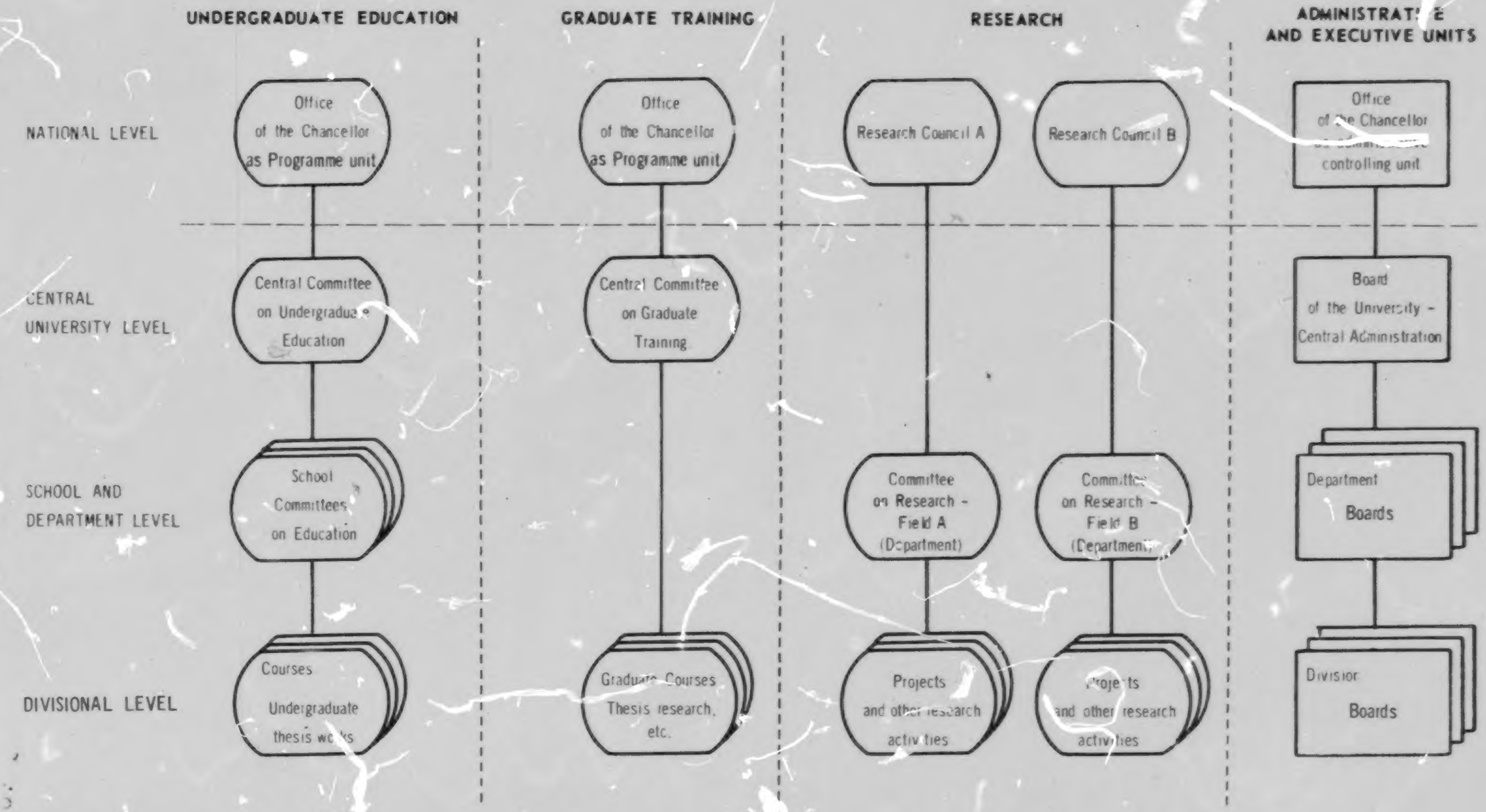
The overall responsible unit for the production as well as the policy questions within the university programmes is the Board of the University. To a certain extent the departments and divisions will act as primary responsible units of their respective levels even in questions related to the content of the programmes. The production units will, as said above, have an influence on the programme policy through restrictions on production.

The organizational principle is briefly that :

i) the programme planning,
ii) the programme information and programme feed-back,
iii) and the resources for the programme

Figure 7.6

PROGRAMME ORGANIZATION AT CHALMERS


UNDERGRADUATE EDUCATION
GRADUATE TRAINING
RESEARCH
ADMINISTRATIVE AND EXECUTIVE UNITS
NATIONAL LEVEL
CENTRAL UNIVERSITY LEVEL
SCHOOL AND DEPARTMENT LEVEL
DIVISIONAL LEVEL
Office of the Chancellor as Programme unit
Central Committee on Undergraduate Education
School Committees on Education
Courses Undergraduate thesis works
Office of the Chancellor as Programme unit
Central Committee on Graduate Training
Graduate Courses Thesis research, etc.
Research Council A
Committee on Research - Field A (Department)
Projects and other research activities
Research Council B
Committee on Research - Field B (Department)
Projects and other research activities
Office of the Chancellor [illegible] controlling unit
Board of the University - Central Administration
Department Boards
Division Boards

should follow the programme channels (see Figure 7.6).

At each level, however (division, department, university), the considerations made in the programmes have to be checked with other activities within the production unit before moving on to the upper or lower level. For example, the programme plan of a Committee of Research, corresponding to a Field of Research, had to be submitted to the Board of the Department in order to check how the proposed Research programme would fit other programmes, staff, space, financial resources, etc.

### Summary of the organizational system

We have built for each programme a hierarchy of decision units, responsible for the planning and the control of the programme. Furthermore, for each executive level we have defined decision units responsible for the execution or production of the programme activities.

The principle followed is that by having a certain degree of distinction between the roles of the programme units and the roles of the production units, a better result is obtained. This is futher analyzed in section 6, Decision Structure.

The principal organizational structure of the university can be seen in Figure 7.6.

## 5. PLANNING SYSTEM

### Introduction

In the preceding sections we have defined the following items of the programme budgeting model :

Programme Structure
Financing Structure
Organization Structure

We may consider these parts as the static parts of the model. In the planning system we are going to describe the dynamic behaviour of the organization within the framework of programmes, objectives of the programmes and means to manage the programmes. The description of the planning system will at the beginning concentrate on the tools for planning and decision-making as plans and information systems and after that, the planning and budget procedures will be described. Finally the need for a general information system for the planning and the decision-making will be discussed. The "network" of the information streams and the content of the information will be further analyzed in Chapter 8.

## The plans in the Programme Budgeting System

The fundamental items in the planning system are the plans. The plans could be defined as an organization of data or information to describe a certain subject related to a time period. In PPBS the primary subjects are the programmes and therefore we will try to establish Programme Plans in order to estimate the present or future outputs and input requirements of the programmes.

The Programme Plans will firstly show the following variables :

- The Output or the performance within the programme. The contribution of the performances for the fulfilment of the objectives.
- Total costs or resources needed.
- Different output/cost alternatives.

Secondly the Programme Plans show :

- Financial calculations of the different types of resources needed in the programme alternatives.
- Physical calculations of the different types of resources needed in the programme alternatives.

Each programme will have plans which will consider different time-periods such as

- Long-term plans (3 - 10 years);
- Annual plans (1 - 3 years);
- Short-term plans (less than one year);
- Operational plans.

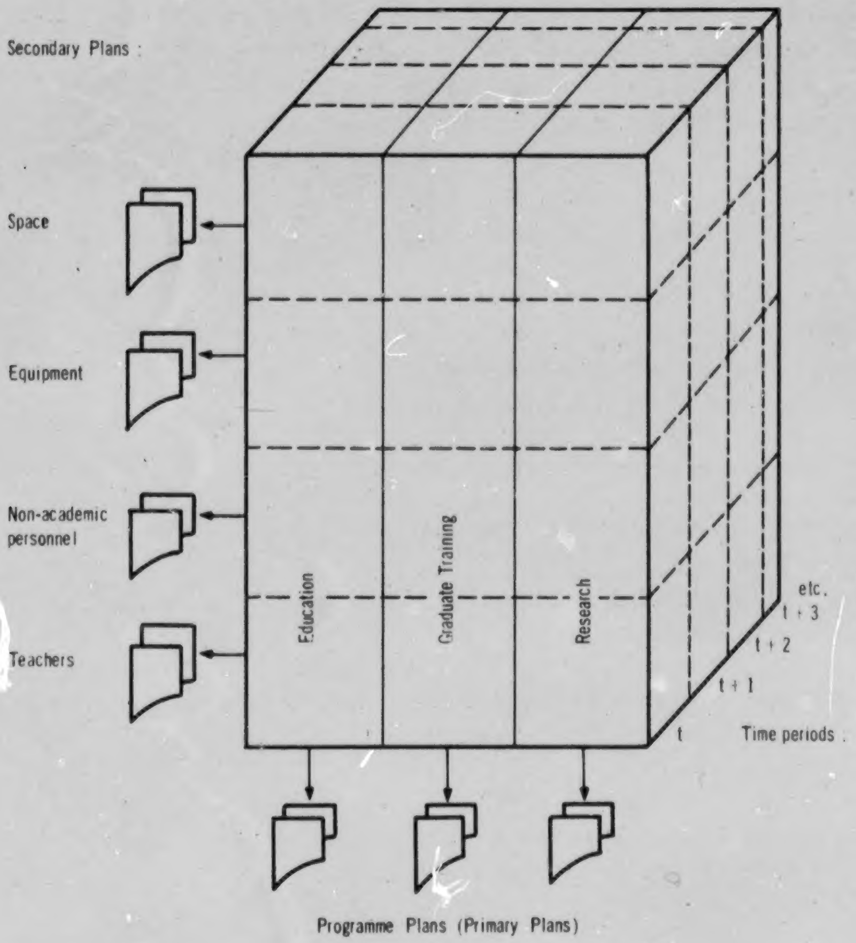
The Programme Plans will at all stages and levels interact with Secondary Plans such as :

- Staff plans;
- Equipment plans;
- Space and Building plans;
- Organizational plans.

The secondary Plans are mostly related to such production units as the divisions, departments, university, etc..The aim of Secondary Plans is to estimate and aggregate the requirements of certain kinds of resources that are limited or of considerable importance, e.g. investments, new staff posts, etc. The principle and relationship between the Programme Plans and the Secondary Plans are shown in Figure 7.7.

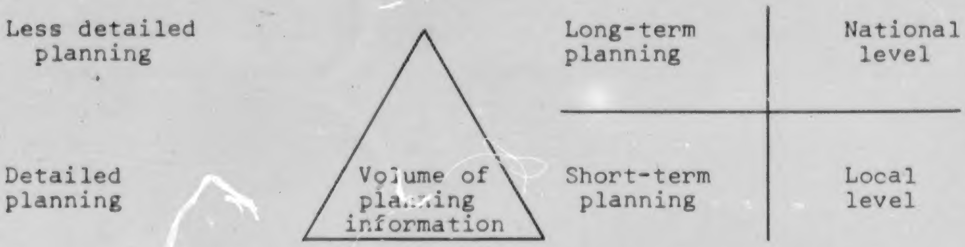
Figure 7.7

PROGRAMME PLANS, SECONDARY PLANS AND TIME PERIODS


Secondary Plans :
Space
Equipment
Non-academic personnel
Teachers
Education
Graduate Training
Research
etc.
t + 3
t + 2
t + 1
t
Time periods .
Programme Plans (Primary Plans)

The content of different plans is described below in the planning and budget procedure. In general one can say that the plans of all kinds are more detailed in short-term planning at lower decision level than long-term planning at higher levels.

Figure 7.8 : PLANNING INFORMATION VERSUS PLANNING LEVELS


Less detailed planning
Detailed planning
Volume of planning information
Long-term planning
National level
Short-term planning
Local level

## The Planning and Budgeting Procedure

The planning and budgeting procedure is described in this section in chronological order for each decision level. Examples of the content of the different plans and budget formats for the research programme are shown. The principles of planning and the co-ordination at the national level are also discussed. Finally the budget cycle is shown.

### a) Planning and budgeting at the divisional level

The plans produced at the divisional level are as follows :

- Course plans (Undergraduate Educa[illegible]);
- Course plans (Graduate Training);
- Graduate Training plan (aggregation of individual graduate student curricula);
- Research project plans;
- Aggregate divisional plans (divisional budget, staff plan, equipment plans, space plan).

The course plans consist of a course programme containing a brief description of the academic content of the course and a numeration of lecture and laboratory hours. The total student time required for the course (even time for own studies) is also estimated. The course programme is accompanied by a course budget, which shows all the relevant costs for the course within the division. Number of students, group size, number of groups, hours per group and type of teaching, total teaching load, etc., are presented in the budget and the costs for the different parts of the course are calculated. In many cases the standard cost method could be used i.e. each activity, like one lecture hour, has a certain "price". The standard cost method in the budgeting simplifies the calculations.

Course plans and course budgets are also made for the graduate courses. The total Graduate Training programme, however, needs to be specified by the division. Some of the additional activities, such as thesis work within the projects are, as emphasized before, supported through the Research programme but there are other activities and items for Graduate Training which should be supported by the Graduate Training appropriation and therefore be calculated separately in a budget for Graduate Training activities : for example, examination costs, scholarships, etc. The number of graduate students and the additional costs for the Graduate Training are specified in this budget.

The research activities within the division are presented in terms of projects. Even the unspecified research activities could be presented in project terms. Such a project budget is presented in Figure 7.9. As in the course budget there is one part devoted to a description of the expected output of the project (A) and the other parts deal with the costs for the project. The project budgets are however different to the other budgets since they cover more than one year. In the budget outline (see Figure 7.9) already existing staff is shown separately from additional project staff.

The budgets for the different programme activities within the divisions are brought together into the divisional budget.

When the budget of the division is made up, an estimation of the total divisional requirements for staff, equipment, space and other resources, in order to fulfil the programme activities, can be made. These requirements are shown in the Secondary Plans which, as you can see, are related to the division (the production unit), through the divisional budget.

### b) Planning and budgeting at the department level

The plans produced at the department level are as follows :

- Undergraduate School Plan;
- Plan for the Research Field(s);
- Aggregate department plans (department budget, staff plan, equipment plan, space plan).

The course plans from the "producing" division are presented to the Committee of Undergraduate Education, which is responsible for an undergraduate school. Within these committees an Undergraduate School Plan has to be worked out containing the educational programme for the school (courses, schedules, rules, etc.) and the corresponding budget for the school. The budget contains figures showing student numbers per year of study and per course, costs for the courses and estimates of expected student performances. The budget for the school also includes the costs of courses supplied by other departments.

The plans of the research projects of the divisions are submitted to the Committees of Research, responsible for a Research Field where the different project plans are co-ordinated. The treatment and evaluation of the project proposals at this level should, according to our opinion, only be concerned by such questions as :

- Unclear project descriptions;
- Similar project proposals (same projects proposed by more than one research group);
- Doubtful or incomplete budget calculations;
- Conflicting projects (several projects needing access to resources

Figure 7.9

PROJECT BUDGET

Name of the project :

Project leader :

Starting : Ending :

---

A The aim of the project :

(What results are expected and the importance of these expected results)

---

B The content of project :

(Description of the research methodology and the time schedule)

| Budget : | Year 1 | | Year 2 | | Year 3 | | Year 4 | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | hours | costs | hours | costs | hours | costs | hours | costs | |
| C Fixed university staff | | | | | | | | | |
| Scientists | | | | | | | | | |
| Assistants | | | | | | | | | |
| Technicians | | | | | | | | | |
| Additional staff : | | | | | | | | | |
| Scientists | | | | | | | | | |
| Assistants | | | | | | | | | |
| Technicians | | | | | | | | | |
| Total staff : | | | | | | | | | |
| Expenses | | | | | | | | | |
| Computer time | | | | | | | | | |
| Administration | | | | | | | | | |
| Equipment | | | | | | | | | |
| Space costs | | | | | | | | | |
| Total costs | | | | | | | | | |

which are scarce such as laboratories, workshops, space, etc.)

- Long-term research policy - new research areas.

During this phase of scientific evaluation new research proposals by the individual researcher should be evaluated by the supporting agency at the national level and not stopped within the university.

The budget of the Research programme must be more detailed than other budgets of the department, due to the fact that the research questions in this model are more centralized than, for example, the educational programme. This will be further discussed in point 6, together with the general decision structure.

In Figure 7.10, an example of a budget format for the Research Programme in Field X is shown. In this budget sheet the costs of each research project within the research field are shown as is the participation of fixed university staff (professor, assistant lecturer, etc.) for each project. It is very important that the national supporting agencies be aware of these costs. In short-time planning the costs of the fixed staff are impossible to change and in an optimal planning these costs should of course be considered (see section 6).

The budgets for the Undergraduate programme and the Research programme are brought together in the department budget. This budget also includes the costs for the Graduate Training programme within the department. The proposals concerning the graduate training activities are however unchanged from those proposed by the divisions, due to fact that Graduate Schools do not at present exist within the university. Each subject manages the graduate activities at the divisional level.

The department budget is similar to the divisional budget and will consequently lead to Secondary Plans as :

Department Staff Plan;
Department Equipment Plan;
Department Space Plan.

It is in the staff plan of the department that the most important staff planning is shown. In general the divisions need approval of new staff places by the departments. New professorships are proposed both in the Research Programme Plan and in the staff plan.

c) Planning and Budgeting at the University level

The plans produced at the university level are as follows :

- Undergraduate Programme Plan;

Figure 7.10

RESEARCH FIELD : X

Department :

Year :

| Project name (reference to description) | Project Leader | Project schedule | | Man-days | Costs for Fixed University staff | | | Cost for Additional staff | | | Expenses Admin. | Computer time | Equipment | Space | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Starts | Ends | | Scien-tists | Assis-tants | Techni-cian | Scien-tists | Assis-tants | Techni-cian | | | | | |
| | | | | | | | | | | | | | | | |

- Graduate Training Programme Plan;
- Plans of the Research Programmes;
- Aggregate university plans (university budget, university staff plan, university equipment plan, university space plan).

The Undergraduate Programme Plan is an aggregation of the Undergraduate School Plans from the department and has a similar design. The proposals from the departments are evaluated by the Central Committee of Undergraduate Education and perhaps adjusted or cut down. The Central Committee of Undergraduate Education has in most cases the final responsibility for the performance of education within the university. The influence from the Office of the Chancellor has decreased.

All graduate activities within the university are included in the Graduate Training Programme Plan. This plan shows the number of graduate students and their distribution in the fields of research. Furthermore, the student performances should be described in quantitative terms. The budget for the Graduate Training programme should show the costs for the graduate course programme, the costs for the examination of graduate students and the costs for scholarships and the expenses to graduate students.

The Plans of the Research programmes at the university level are in most cases similar to the plans at the department level. A Central Committee of Research will assist the Board of the University on more general aspects such as :

- The long-term growth of the different research fields of the university;
- The equilibrium between the programmes of the university;
- Proposals of new professorships, new areas of research, research equipment, etc.

The Undergraduate programme, Graduate Training programme and the Research programmes are brought together in the university budget. In the yearly university budget the usual Secondary Plans are presented :

- The University Staff Plan;
- The University Equipment Plan;
- The University Space Plan.

At the university and department levels the long-term planning of the programmes is developed. In the yearly budget of the university an estimate of costs and outputs in the programme plans for at least seven years ahead is calculated. The Secondary Plans are also calculated according to this planning period

### d) Planning and Budgeting at the national level

As said before, the proposals regarding the Undergraduate and Graduate Training programmes are presented to the Office of the Chancellor which has to evaluate the proposals and present the adjusted plans to the Government, together with the requests from other universities.

The Research programmes will be presented to the responsible Research Agency for each Field of Research. Thus the Programme Plans of the university will be submitted to the programme-responsible agencies at the national level. In these Programme Plans the total costs of the programmes are calculated, even the costs for equipment and space. In the planning at the national level there is, however, a need for a special co-ordination of the public investments of equipment and building and therefore the Equipment Plan and the Space Plan of all universities have to be presented to :

- the Equipment Board for the Swedish Universities;
- the National Board of Building.

The aim of the Equipment Board is not to provide the resources for equipment. It is the programme agencies who contribute resources for investment in equipment, through the appropriation programme, to the universities. The role of the Equipment Board is to serve as a technical adviser in the investment planning and to centralize purchases of equipment. The planning function of the Equipment Board should primarily serve and co-operate with the universities, so that the Programme and Equipment Plans of the university are as good and as realistic as possible.

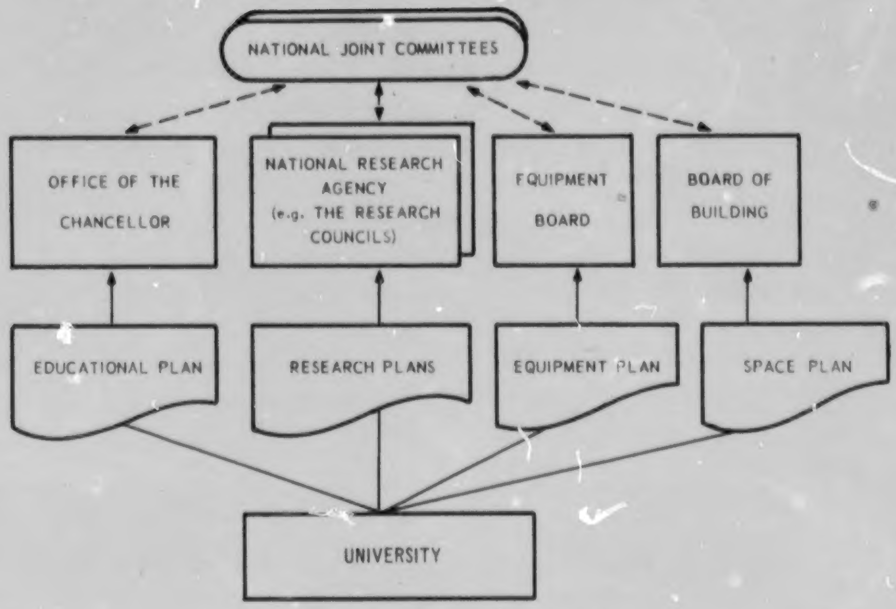
The National Board of Building is responsible for the buildings. The costs for renting the buildings are paid by the universities which receive resources for the space costs in the appropriations programme. The National Board of Building primarily has to co-operate with the universities in establishing the Space Plan. In the long-term planning of building investment the National Board of Building also has to co-operate with the educational and the research authorities.

The plans from the university will thus be delivered to the national agencies as shown in Figure 7.11.

There will of course be a great need for joint planning between, for example :

- Education and research;
- Research and equipment planning;
- Research and space;
- Space and equipment, etc.

Figure 7.11


NATIONAL JOINT COMMITTEES
OFFICE OF THE CHANCELLOR
NATIONAL RESEARCH AGENCY (e.g. THE RESEARCH COUNCILS)
EQUIPMENT BOARD
BOARD OF BUILDING
EDUCATIONAL PLAN
RESEARCH PLANS
EQUIPMENT PLAN
SPACE PLAN
UNIVERSITY

The desired main principles are as follows :

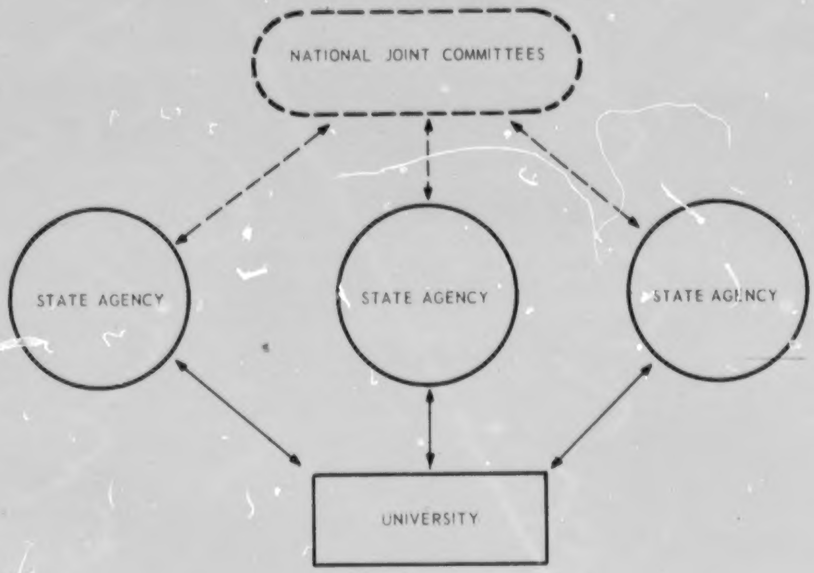
- i) The co-ordination of the programmes, staff, equipment, space, etc., should be done at the university level in the university plans in co-operation with the national agencies, respectively.
- ii) If there is a need for co-ordination between national agencies concerning, e.g. programme policies (co-ordination between education and research) and other questions related to the university (building planning, etc.) that can not satisfactorily be done within the university planning, national joint committees on specific subjects are to be established.
- iii) A responsible agency for the national co-ordination of university matters is still the Office of the Chancellor of the Swedish Universities.

The above-mentioned principles will, compared to the present situation, lead to a greater decentralization of "co-ordinated planning" of the universities. As we pointed out in Chapter 3 the co-ordination of the university question at the national level is not good (especially between education and research and also between research and building and equipment planning) and one way to solve the co-ordination problem at the national level is to decentralize some of the co-ordination to the universities. The plans submitted to one state agency should include the main consequences for the other programmes, staff, space, equipment, etc., for different proposed alternatives. In this way the need for planning co-ordination between national agencies could be decreased and the agencies could concentrate on their main questions and evaluate alternative strategies in co-operation with the universities.

The plans are only co-ordinated at the national level with a tendency toward strong centralization. The co-ordination is, however, not sufficient. It could be done through the universities as well as by national joint committees.

Figure 7.12

PROPOSED CO-ORDINATION MODEL



### e) The budget cycle

In Figure 7.14 the budget cycle is shown. This time schedule does not differ from the actual university budget cycle except for the resources for the projects that for the present come from the Research Councils. The researcher usually applies for these resources the year before or even the year he will use them. In this proposed budget cycle the resources for the total Research programmes will be requested in the regular budget cycle 1 1/2 years before the actual year. The nature of short-term planning in the research support will therefore be avoided. This does not prevent

Figure 7.13

CYCLE OF PLANNING AND BUDGETING AT CHALMERS UNIVERSITY OF TECHNOLOGY

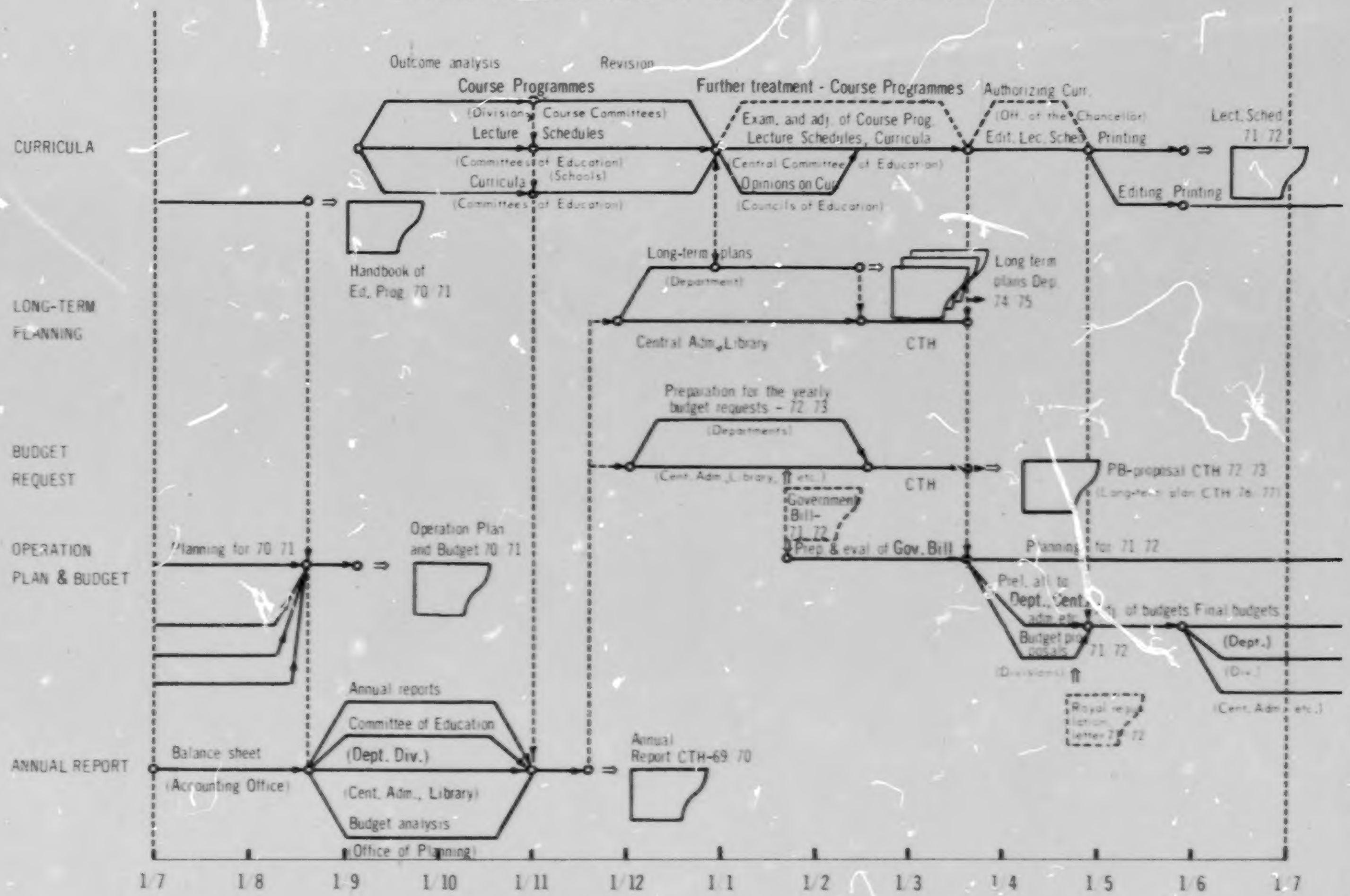
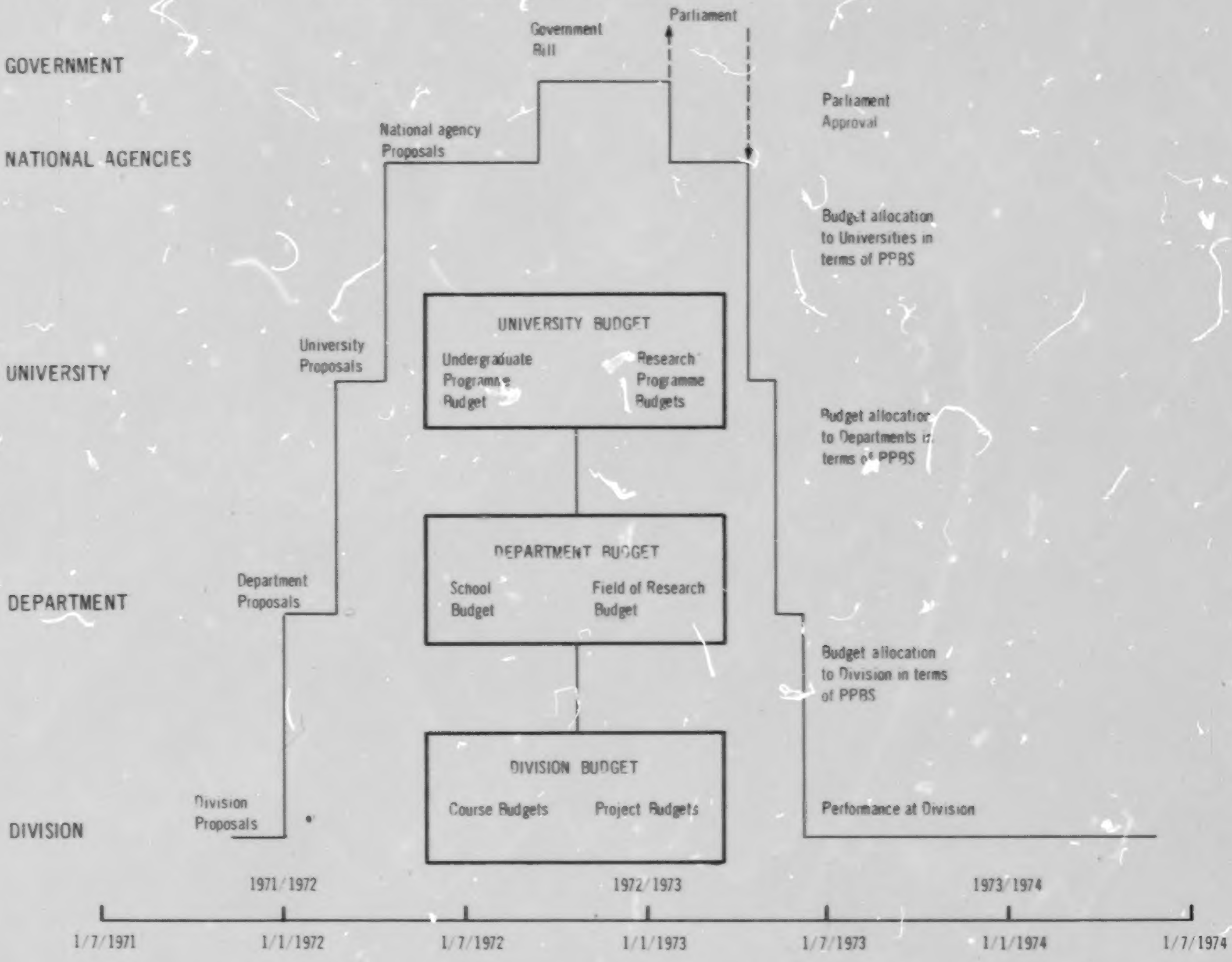

CURRICULA
LONG-TERM PLANNING
BUDGET REQUEST
OPERATION PLAN & BUDGET
ANNUAL REPORT
Outcome analysis
Revision
Course Programmes
(Divisions) Course Committees)
Lecture Schedules
(Committees of Education)
Curricula (Schools)
(Committees of Education)
Handbook of Ed. Prog. 70/71
Further treatment - Course Programmes
Exam. and adj. of Course Prog. Lecture Schedules, Curricula
(Central Committee of Education)
Opinions on Cur.
(Councils of Education)
Authorizing Curr.
(Off. of the Chancellor)
Edit. Lec. Sched.
Printing
Editing
Printing
Lect. Sched 71/72
Long-term plans
(Department)
Central Adm., Library
CTH
Long term plans Dep. 74/75
Preparation for the yearly budget requests - 72/73
(Departments)
(Cent. Adm., Library, etc.)
CTH
Government Bill 71/72
PB-proposal CTH 72/73
(Long-term plan CTH 76/77)
Planning for 70/71
Operation Plan and Budget 70/71
Prep. & eval. of Gov. Bill
Planning for 71/72
Prel. all. to Dept., Cent. adm. etc.
Budget proposals 71/72
(Divisions)
Royal regulation letter 71/72
of budgets
Final budgets
(Dept.)
(Div.)
(Cent. Adm., etc.)
Balance sheet
(Accounting Office)
Annual reports
Committee of Education
(Dept. Div.)
(Cent. Adm., Library)
Budget analysis
(Office of Planning)
Annual Report CTH-69/70
1/7
1/8
1/9
1/10
1/11
1/12
1/1
1/2
1/3
1/4
1/5
1/6
1/7

Figure 7.14

THE BUDGET CYCLE FOR THE FISCAL YEAR 1973/74


Parliament
Government Bill
GOVERNMENT
Parliament Approval
National agency Proposals
NATIONAL AGENCIES
Budget allocation to Universities in terms of PPBS
UNIVERSITY BUDGET
Undergraduate Programme Budget
Research Programme Budgets
University Proposals
UNIVERSITY
Budget allocation to Departments in terms of PPBS
DEPARTMENT BUDGET
School Budget
Field of Research Budget
Department Proposals
DEPARTMENT
Budget allocation to Division in terms of PPBS
DIVISION BUDGET
Course Budgets
Project Budgets
Division Proposals
DIVISION
Performance at Division
1971/1972
1972/1973
1973/1974
1/7/1971
1/1/1972
1/7/1972
1/1/1973
1/7/1973
1/1/1974
1/7/1974

the national research agencies (e.g. the Research Councils) from saving resources for short-term support of activities currently arising during the fiscal year. The principles for the resource allocation are briefly discussed in point 6 below.

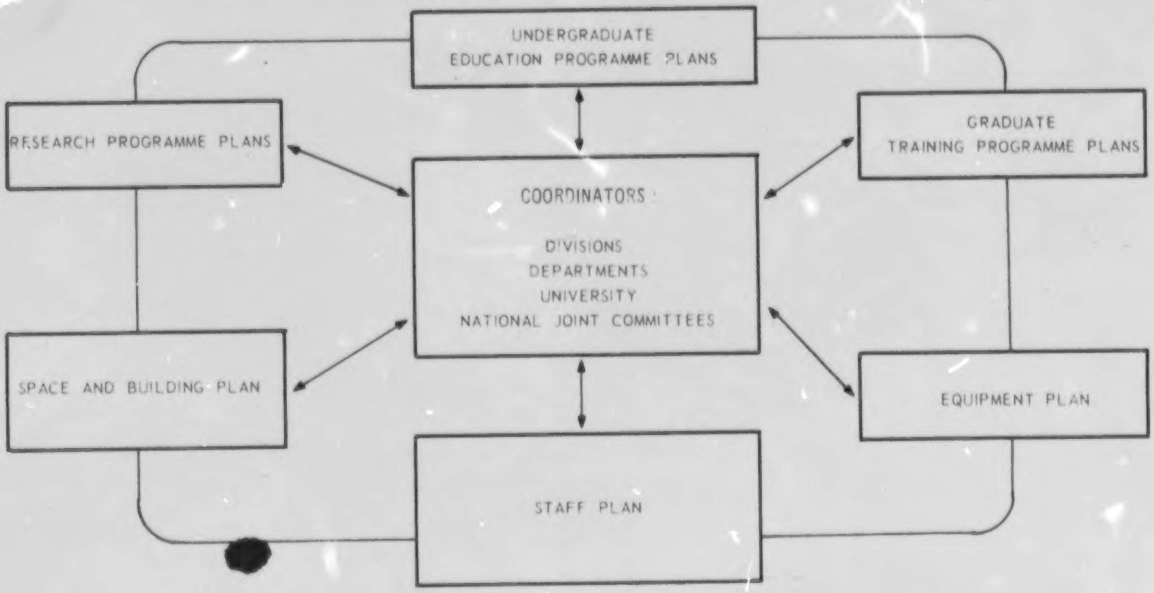
## The Need for a General Information System

In the planning and decision system we have a need for information of all kinds; proposals, reports, outcome analyses, estimates of inputs and outputs, plans of different activities, etc.

Within the university there is, in the planning procedure, a need for exchange of information between programme units and production units when working out the Programme Plans and the Secondary Plans of the divisions and the departments. In Figure 7.6 you can see that the information in the planning on the one hand follows the "programme channels", i.e. from a lower programme unit to a higher programme unit. On the other hand, the information is channelled to the production units (divisions, departments) at each level. This network of information is roughly described in section 5 and the principles of the information flows at the national level have also been shown in section 5(d).

The aims of an information system will partly be to co-ordinate the Programme Plans and the Secondary Plans at each level. The responsibility for such co-ordination is laid upon the production units (divisions, departments or university).

Figure 7.15


UNDERGRADUATE EDUCATION PROGRAMME PLANS
RESEARCH PROGRAMME PLANS
GRADUATE TRAINING PROGRAMME PLANS
COORDINATORS
DIVISIONS
DEPARTMENTS
UNIVERSITY
NATIONAL JOINT COMMITTEES
SPACE AND BUILDING PLAN
EQUIPMENT PLAN
STAFF PLAN

In order to further analyze the need for information in the proposed model, we have made an outline in Chapter 8 of such an information system for the PPBS model applicable at the university.

## 6. DECISION STRUCTURE

### Introduction

In this section we are going to discuss the general decision structure of the Research programmes and the Graduate Training programme. Which decisions are made by whom in the proposed model ? This question could not at the present stage of the study be satisfactorily answered but we will devote ourselves to a general discussion of the desired decision structure.

For future studies this area is proposed to be further examined in a stringent and logical way, for each decision unit and programme, comprising :

i) a definition of the operational objectives;
ii) a classification of the control parameters;
iii) a classification of the external non-controllable parameters.

### The Decision Structure of the Research Programmes

At the top level of the Research programmes we have the national research agencies, which, as said before, could correspond to the present Research Councils. The objective in their planning and decision-making could in this model be very briefly formulated.

| The Objective of the National Research Agencies is : |
|---|
| To initiate and support research activities in their area of research respectively, by allocating resources to universities, state laboratories or private companies. The allocation to the universities should include the total costs for the research activities and, consequently, the National Research Agencies should be responsible for the use of the research resources of the universities, so that the total public research capacity is used in an optimal way, allowing, however, a certain degree of freedom for the scientists to use the resources for unspecified research activities. |

This very rough formulation of the objective of the National Research Agencies differs in some ways from the present tasks of the Research Councils.

Firstly, the resources allocated to universities should cover the total costs. Secondly, the national agencies should be aware of the total available capacity of research within the universities and be responsible that all resources are used in an optimal way. The difference could be shown as follows :

Present character of the allocation of the Research Councils

$$\text{Max} \sum_{1}^{n} E_n$$

$$P_{v1} + P_{v2} + \ldots\ldots. P_{vn} < B$$

$E_n$ = Benefit of project n

$P_{vn}$ = Variable costs of project n

B = Budget frame

To maximize the benefit of the projects by allocating resources for the variable costs of the projects within a budget frame.

Proposed character of the allocation of the National Research Agencies

$$\text{Max} \sum_{1}^{n} E_n$$

$$P_{t1} + P_{t2} + \ldots\ldots. P_{tn} < B \text{ (Budget)}$$

$$S_{min} < S_1 + S_2 + \ldots\ldots. S_n < S_{max} \text{ (Staff capacity}$$

$$E_{min} < E_1 + E_2 + \ldots\ldots. E_n < E_{max} \text{ (Equipment available)}$$

$$M_{min} < M_1 + M_2 + \ldots\ldots. M_n < M_{max} \text{ (Space and building available)}$$

$P_{tn}$ = Total costs of project n

To maximize the benefit of the projects by allocating the total resources to the projects, considering the effective use of present fixed resources such as staff, space and equipment, etc., ($S_{min}$, $E_{min}$, $M_{min}$) indicates the lowest possible use of the fixed resources for the research programme without having unused capacity at the universities.

The main parameter used by the National Research Agencies should therefore be the allocation of resources for the total costs for the different projects. This could preferably be done in such a way that each university receives a programme appropriation corresponding to a Field of Research or a group of projects. If such a lump is accompanied by a list of the approved projects from the national agency and with notations of man-days per project, approval of investments of certain heavy equipment, etc., it would be possible for the local authorities within the university (the Committees of Research) to allocate the resources to projects and auxiliary services according to the university plans.

It is also desirable to obtain appropriations for the projects and programmes covering several years. The advantages of such a granting are many, some of these are :

i) The researchers do not have to apply for project resources every year. The feeling of uncertainty will decrease, which will promote a better research atmosphere. It will also save a lot of time spent on applications to the Research Councils.
ii) It is possible to have a long-term staff policy which will decrease the present very unsatisfactory employment status for the staff engaged in the projects.
iii) The investment policy could be more refined, as well as the total planning of the available physical resources.

Besides the allocation of resources, a National Research Agency must have the main responsibility for establishing new research areas at the universities within its field. This means that decisions of new professorships as well as the programmes for the professors should be made by such an agency after proposal from the university. The National Research Agencies must, however, be aware of some important planning restrictions.

Firstly, a great amount of the resources are fixed and we have already pointed out that the national agencies have to consider the use of the fixed resources in their planning. The project plans and the Research Programme plans are also proposed to include information concerning the use of the fixed resources. (See Figures 7.9 and 7.10 concerning project budgets and a budget of a research field).

Secondly, according to the university law the researcher should have freedom within the subject to choose areas for research. It should therefore be quite clear that it is impossible from a central or local authority to control or plan the activities of a researcher and a minimum part of less his basic organization without the approval and the co-operation of the researcher. The planning must still, to a great extent, be based on the proposals and initiatives of the researchers, not control from authorities.

The decision structure of the Research programmes within the university is characterized by a high degree of independence in research questions of the departments through the Committees of Research. The treatment of research questions at the top university level is kept at a minimum and the Board of the University and the Central Committee of Research only treat long-term policy and co-ordination questions. In the resource allocation the Board of the University only ensures that, from each appropriation of the Research programmes, enough resources are given to central activities such as administration, library, etc.

The real allocation of the resources to research is made in the Committees of Research. In many cases such a committee will collaborate or be identical to the Board of the Department. This is of course the natural way of planning, considering that the allocation of the research resources in most cases will very much influence the use of the big fixed costs such as staff, equipment, space, etc. The optimal allocation of resources will as said above depend on factors such as the economies of scale, marginal costs, institutional factors, price differences, full or remaining capacity, etc. The technique used in this allocation could often not be output-oriented, that is, only consider the benefit of the project. One must at this decision level clarify :

- what has to be done in the project in terms of man-days, computer time, equipment needs, etc.;
- how this will be performed at the division;
- which costs will then arise for the most optimal solution in view of the available resources and other activities within the division.

### The Decision Structure of the Graduate Training Programme

The planning within the Graduate Training programme is according to our definition of which costs this programme should cover (see point 3). The Office of the Chancellor will, with the proposals from the university as a base, grant a programme appropriation in a lump covering the graduate training activities :

- graduate courses;
- examination costs;
- scholarships;
- expenses.

The size of this appropriation will depend on :

- the graduate course programme;
- the number of graduate students.

Any further specification from the Office of the Chancellor is not desirable. The university should allocate the resources to the subjects where additional resources for graduate training activities are demanded. The demand for graduate training activities of the kind we have mentioned here varies a lot from one subject to another depending on the number of graduate students, the nature of the subject, the size of the research, etc. One can therefore emphasize that the main responsibility for the graduate training activities in the total system of education and research must be on the universities through the Central Committee of Research and the supervisors of the different subjects.

## Centralization versus Decentralization

As a conclusion to this section on the decision structure, one can question whether the model will centralize or decentralize the decisions. The answer will be that both will occur.

A general tendency in the present planning and thinking is that educational questions will be decentralized both in terms of responsibility between central and local institutions and geographical performance. In research questions there is a tendency to centralize, or perhaps co-ordinate the research planning due to the fact that research activities claim for more and more resources, and resources of an investment character such as equipment, buildings and even staff.

Although the concepts of centralization and decentralization are very vague and relative the following could be stated.

The model assumes a decentralization of :

1. The planning and the performance of the Undergraduate programme as well as the Graduate Training programme;
2. The performance of the Research programme;
3. The staff policy;
4. The planning for equipment and buildings;
5. The co-ordination of programmes, staff requirement, and buildings.

The model assumes a centralization of :

1. The research policy and long-term planning of the Research programme. (The research questions will be centralized to one agency for each field of research instead of several agencies having responsibility for certain resources).

# 7. OUTPUT ORIENTED FINANCING METHODOLOGY IN THE RESEARCH PROGRAMMES

In Chapter 2, section 5, we pointed out that what is relevant in the discussion of output financing is that "output information" should be given to the decision-maker so that he can judge the benefit of this activity. This output information need not necessarily be quantitative but if it were it would simplify the decision-making.

In Chapter 6 we discussed the different ways to present the output of the research project and several measures and techniques were also presented. Each output measure could give one part of the "scientific truth"but no single output measure has been found enough to judge the value of the research performed.

The Research programme will, in the PPBS model, use an output oriented financing methodology by using the project concept :

i) The objectives of the research project are defined;
ii) The expected value of the project is described;
iii) The total costs of the project are shown.

Project financing means that from a limited budget resources are allocated to projects, considering the expected output of the project in relation to the costs of the project. Some evaluation methods could be used when classifying which project would be realized (see Chapter 6).

It should be pointed out that no output measure has been found valuable enough to judge if a project should be realized or not. In this case so many factors will influence that it is impossible to quantify the possible effects. As a matter of fact the future effects of research are in themselves by definition difficult to predict.

However, if we have a roughly defined project or research task there will be a better chance to judge how and by whom this project should be realized. Here we have figures of time, costs, man-days, etc., that could give us an idea how to allocate the resources.

Experience and knowledge of research questions are utterly necessary in research allocations. The fact of having a researcher judge other research activities in committees, councils, etc., is also in the future supposed to be the most common and useful way to handle research questions.

Many decisions concerning research questions are also based upon past behaviour of the project leader/project group. (Representatives of the Research Councils maintain that the scientist is many times more important than the content of the project when granting resources). It is therefore very important that feed-back in the form of project reports is given responsible units in such a way that the past behaviour of the researcher or the project group could be judged as well as possible.

## 8. SUMMARY OF THE PROPOSED MODEL FOR PPBS AND NECESSARY ADJUSTMENTS OF THE MODEL TO THE PRESENT ORGANIZATION

### Summary of the proposed PPBS model for Research and Graduate Training

The proposed model consists of the following items :

#### 1. The Programme Structure

The programmes defined for the university are :

- Undergraduate Education Programme;
- Graduate Training Programme;
- Research Programme(s);
- External Services Programme.

The Research Programmes corresponds to different fields of research, in most cases related to the departments, which are sub-divided into research projects. From the present Research and Graduate Training Programme some activities for Graduate Training have been separated into a Graduate Training Programme; namely : graduate courses, scholarships, examination costs and certain expenses. The costs for supervisors and the costs for the participation of the assistants in Graduate Activities such as project work and own studies are covered by the Research Programme.

#### 2. The Financing System

Each programme corresponds to a programme appropriation including all relevant costs. The Undergraduate and Graduate Programmes are supported by the Office of the Chancellor of the Swedish Universities. A Research programme is supposed to be totally supported by national agencies for the field of research. Such national agencies could be the present Research Councils or other state agencies. This principle of financing university research will claim for a change of the responsibility for the research questions at the national level. The programme appropriations could be granted for one or several fiscal years.

#### 3. The Organization

For each level of the programmes, programme-responsible decision units will be established. In the research programme the programme-responsible units will be the Committees of Research corresponding to the departments. The Central Committee of Research will furthermore have advisory functions to the Board of the University.

The programme units are responsible for the production or execution of the programme activities. The production units are the divisions, departments or the whole university.

### 4. The Planning System

The tools of the planning system are the plans. These plans could be Programme Plans related to the planning of the programmes and Secondary Plans related to the production planning in the divisions, departments, university, etc. The Secondary Plans describe the consequences of the Programme Plans and could be plans for staff, equipment, space, etc.

The interactions of Programme Plans and Secondary Plans at each level of the university and of the national level are described in the planning procedure. This interaction of plans as well as the possibilities of establishing the plans claims for a good university information system.

### 5. Decision Structure

In the decision structure an attempt to formulate the objectives for the research programmes is made as well as a discussion of the technique to allocate the research resources to research projects. The research authorities will grant resources for the total costs of the research project but some major restraints such as optimal use of the fixed resources at the universities and a certain degree of freedom for the individual researcher in the choice of research activities are taken into account.

Furthermore, it is evident that the proposed model will lead to a decentralization of most of the decisions except for the question concerning the research policy which will be better co-ordinated or horizontally centralized at the national level.

### 6. Output-oriented financing methodology

In the Research programme an output oriented financing methodology will be used by granting resources for goal - or output-oriented programmes which are based on research projects with defined objectives. No single output measure will be used in the evaluation of the projects but there is a set of valuable measures for describing and judging the projects that could be used. The main tools for the evaluation of the projects and the project groups/scientists will still be the project reports.

## Necessary Adjustments of the proposed Model to the Present Organization

In section 3 we discussed three different alternatives for the financing of the Research Programmes. The model is built on the third alternative : all public research activities at the universities (and other research organizations) are financed by research authorities (Research Councils or similar agencies).

The present organization however corresponds to the second alternative : the total basic organization for the research at the universities is financed by the educational authorities. Specific project costs are financed by research agencies. If we assume that the present organization for the financing of the research activities of the universities will not be changed (alternative 2) in the near future, what adjustments of the proposed model for PPBS are necessary ?

Referring to the parts of the model presented in this chapter it is necessary to analyze the different parts and examine what could be applied to the present organization. We then find that many parts of the model would be appropriate and valuable to implement at the university. Below we analyze how the different parts of the proposed model fit the present organization.

### Programme structure

The division of the activities into three different programmes, as proposed in section 2 in the model, is appropriate for the present organization. The classification of the costs and activities of the different programmes, for example between Research and Graduate Training, does not depend so much upon whether financing alternative 2 or 3 is chosen.

### Organization

The main features of the proposed organizational framework have already been introduced for the Undergraduate programme, Graduate Training programme as well as the distinction between programme units and the production units. It has also been discussed how scientific and research questions should be treated in the organization. The establishment of the proposed programme-responsible units for the Research programme at the department level, the Committees of Research, is at present appropriate.

### Planning and information system

The most valuable thing to do now is perhaps to introduce a planning procedure and an information system based on what is proposed for the model.

First, the plans - Programme Plans and Secondary Plans could be very useful as an information tool for the planning authorities. If we take the

Research Programme Plans, it is quite clear that if a Programme Plan for a Field of Research is established, and all costs covered by the different supporting national agencies, these agencies and the university would benefit from such a total plan for a Field of Research within the university. The national agencies, for example the Research Councils, would have better information of the shape and the performance of the total research activities in the field as they would be aware of what capacity and facilities are available at the university. This could help the Research Councils in, for example, the granting of resources to the research projects, investment of research equipment, long-term planning of research activities in the field, etc.

In the present situation we have found a great need for better information from and within the university. Decisions at the national level as well as within the university are made without appropriate information of the consequences and possible effects.

The improved information system will, within the present organization, promote better co-ordination at the national level and within the university. The decision units will at an early stage be aware of what is planned by other units for other programmes or functions and this will perhaps incite a better co-ordination of planning.

### Decision structure and financing system

The difference between alternatives 2 and 3 could be referred to the decision structure. The decision structure depends upon :

- which are the decision units;
- which responsibility and objective each unit has;
- what parameters (means of control) each unit possesses.

The present picture of these factors, as shown in the preceding chapters, does not satisfy the proposed model for PPBS, especially at the national level. (see Table 3.5, criteria 1 and 2).
The content of the decisions, however, also depends on :

- information to the decision unit (see Figure 2.5, criteria 3);
- experience, knowledge and ability of the decision-makers.

As pointed out for the planning system, an improved information system could to certain degree serve as a substitute to a doubtful decision structure and organization. By giving the present decision units relevant information of what is planned, for example, in other programmes, in staff policy, for available equipment, etc., one can assume that better and co-ordinated decisions will be made.

The most difficult question within the university, even if the information system and the planning are improved, is how to allocate the resources for the research supported by the educational authorities. What is the objective in such an allocation of the resources ? Should the individual scientist be supported by the university even though he has received a project appropriation from a Research Council but needs a bigger basic organization for his research, or should the university on the other hand support the scientist, who has been "forgotten" by the Research Councils ?

In the absence of appropriate objectives for the research question within the university and an appropriate organization picture of the research planning and decision-making, the university could probably act along the following lines :

- each scientist will firstly be ensured a minimum support for his research (including his salary, expenses, technicians and administrative staff). This has to be done according to the university law;
- the remaining resources could be allocated partly in co-operation with the Research Councils (or similar), partly by the university through the Central Committee of Research (the Board of the University) and the Committees of Research (the Board of the Departments).

### A Plan of Action for the Implementation of the proposed Model for PPBS

Below are presented the desired steps from the present organization (alternative 2) which approach the PPBS model (alternative 3), which could be adopted in the near future.

1. Establish a nation-wide classification of Fields of Research and corresponding Research programmes that could be useful and practical at all levels of performance.

2. Improve the information and planning system according to the PPBS model (Programme Plans, Secondary Plans, cost accounting and outcome analyses according to the proposed classification of programmes). The information system should be built in such a way that it avoids "double-information" and minimizes the bureaucracy.

3. Introduce possible co-ordination in the planning procedures within the university and between the university and the national level. (Co-ordination of budget requests, research applications, reports, outcome analyses, etc.).

Decentralize as much as possible to the universities from the national agencies :

- The programme planning of the Undergraduate and Graduate Training programmes (The Office of the Chancellor);
- Administrative rules (The Office of the Chancellor);
- Staff policy (The Office of the Chancellor);
- Equipment planning (The Equipment Board);
- Building planning (The National Board of Building);
- The co-ordination of the programmes and the secondary functions.

5. Move most of the resources for variable costs for research at the universities, supported by the Office of the Chancellor, to the Research Councils (expenses, computer time, some costs for equipment, some costs for salaries to assistants, technicians). The remaining resources will be the costs for the fixed staff - salary costs for professors, assistant professors, etc. These costs are fixed and cannot be changed in the short-term planning and therefore one can say that it does not matter by whom these costs are supported in the short-term. In the proposed optimal model for PPBS (alternative 3) these costs also have to be considered in the short-term decision-making at the Research Councils and within the university.

6. Move the appropriation for investment of equipment from the Equipment Board to the Office of the Chancellor (equipment for the undergraduate education) and to the Research Councils (equipment for the research activities). The Equipment Board will remain as a focal point for technical advice in purchasing questions and as a co-ordinator of the university equipment planning.

7. A better formulation and definition of the goals and the objectives of the programmes and of the decision units, both at the national level and within the university.

8. Establish the proposed decision units for the Research programme within the university (Committees of Research).

9. Improve the decision-making in the responsible decision units by :

   - formulating objectives;
   - improved information;
   - better administration (optimal not maximum administration);
   - better distribution of representatives in the decision bodies.

## Proposal for Future Studies

The scope of the future studies will of course depend on how the proposed model will be accepted and what possible effects it could have. Some items of the proposed model are without any doubt of "long-term character" and it will perhaps take time to realize these parts.

Some possible subjects for further studies are presented below :

1. An extended analysis of the decision structure and operational behaviour comprising :
   - i) a definition of the operational objectives for each programme and decision unit;
   - ii) a classification and analysis of the control parameters for each decision unit;
   - iii) a classification and analysis of the external non-controllable parameters.
2. An extended analysis of the need for information for each decision unit. The information analysis should lead to an optimal planning system where duplicated information and irrelevant flows of information are avoided.
3. An analysis of how to perform a good management system without an increasing volume of administration and irrelevant information. When establishing refined management systems there is a great risk that the bureaucracy increases. The time and the efforts spent in committees by individuals as well as the costs of the administration and information systems have a tendency to increase in systems like PPBS. Great efforts have therefore to be made to avoid such failures in the future.

## Chapter 8

# OUTLINE OF AN INFORMATION SYSTEM FOR HIGHER EDUCATION AND RESEARCH AT CHALMERS UNIVERSITY OF TECHNOLOGY

The PPBS model presented in Chapter 7 includes an outline of the planning system. The most important elements of information that have to be passed within this system are :

- Goals of the programmes;
- Allotment of appropriations;
- Achievements at the programme level.

Besides this *primary information* there is *secondary information* concerning auxiliary functions like buildings, equipment and staff. Primary and secondary plans have to be carefully co-ordinated at the *university level* where an optimal utilization of available resources is the aim of planning activities.
This process of co-ordination together with the general planning of each programme require an extensive information system which shall be outlined in this chapter.

## 1. GENERAL THEORY (1)

The following description of the decision system is based upon the assumption that the activities within the system can be divided into *fields of decision*. Each field must be carefully defined with regard to types of activities that take place.

Each field of decision is characterized by a number of decisions that are made by the responsible units (persons) of the field. We group these decisions into six levels of decision constituting our hierarchical model.

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1) The technique presented in this chapter originates from Mr. Bo Ekman, *Beslutsrationalisering*, Almqvist & Wiksell AB, Stockholm, 1970.

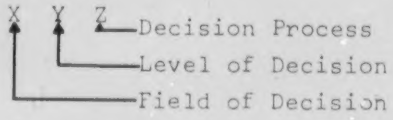
1. Long-term Planning (3-5 years)
2. Annual Planning
3. Short-term Planning (less than one year)
4. Operational Decisions
5. Current Activities
6. Control, Follow-up.

Each decision is assumed to occupy a position in the stream of information. The decision process is connected to three types of information.

- Information from other processes (input).
- Basic information presented to the decision-makers.
- Information emanating from the decision (output).

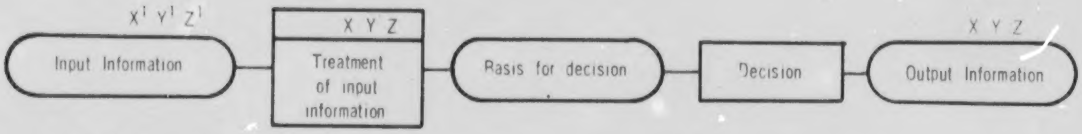
The output is usually a part of the basic information, since this comprises a proposal preceding the actual decision.

When we look at the stream of information, most of the pieces of information within the system go from one decision process to another. However, certain information arrives from external sources and thus represents the external control of the system. For the purpose of tracing each document of information we assign to each decision process a code number constructed in the following way.


X
Y
Z
Decision Process
Level of Decision
Field of Decision

X, Y, Z may all, if necessary, consist of more than one digit. The reports are assigned the same code numbers as the decision process from which they emanate.

What has been said about the stream of information is illustrated by the following diagram which represents one decision process (code number X Y Z).


X¹ Y¹ Z¹
Input Information
X Y Z
Treatment of input information
Basis for decision
Decision
X Y Z
Output Information

## 2. A MODEL OF DECISION FOR CTH

Appendix III B shows a proposed model of decision for CTH. The fields of decision are :

1X. Undergraduate Technical Education at School X. The programme area was described in Chapter 7.

20. Graduate Training. The programme area was described in Chapter 7. One should observe that this is a complementary programme and does not include all costs and activities necessary to perform graduate training.

3X Technical Research belonging to Engineering Field X. The definitions of the engineering fields will be found in Chapter 7.

1X, 20 and 3X constitute the Main Programmes of the system. The following fields of decision are all auxiliary which in this case means that their goals are to make the main programmes as effective as possible. The decisions made within the main programmes all have the caracter of expert decisions, i.e. facts of the programme areas are considered. Administrative and economic problems are as far as possible referred to the auxiliary programmes.

41. Economy takes care of the budgeting procedure, the final allocation of resources and the cost and cash accounting. Especially important is the co-ordination of the economies of the programmes. Since all three of the main programmes finally take place at the divisional level it is important to recognize what effects this has on the individual budgets of the programmes. Further, Economy has to take into account economic problems due to investments of equipment and building activities.

42. Staff is responsible for all matters related to the employees at the university. It is important that one organizational unit is responsible for all the personnel. What was said about co-ordination under Economy applies to Staff too.

The fields 51 through 54 are all concerned with administration planning and the co-ordination of the subprogrammes (schools, engineering fields).

51. Educational Administration. Since education comprises both UTE and GT and since UTE further consists of six schools there is great need for a central administrative unit giving rules and restrictions for the subprogrammes, taking care of common problems in connection with examination, registration, etc.

52. Research Administration. The co-ordination of resources from different external sources to the engineering fields at the university requires an organization for research administration which assists the individual scientists in working out project applications and plans, commission contracts, etc. Further, information about current research at the university has to be assembled to be distributed to the users.

53. Planning and Administration of Buildings. Two important areas are involved : (1) The planning and dimensioning of new buildings and (2) the registration and satisfying of current space resources and needs. Both tasks should be solved in close co-operation with university officials. As is indicated by input information the organization must be economically responsible for activities.

54. Planning and Administration of Equipment. This field of decision is supposed to handle matters concerning expensive capital investments. Equipment belonging to this category can often be utilized by more than one division and therefore the second task of registrating and satisfying current resources and needs apply also to this field.

It should be pointed out that the fields of decision do not necessarily correspond to organizational units. The activities of the fields may be spread out among different units. However, we shall assume there is a central control of each within the university.

## 3. HIERARCHICAL MODELS OF DECISION

The levels presented in section 1 are general. Regarding most fields of decision, the levels will have to be confined depending on the character of the activities; especially the distinction between long-term, annual and short-term planning. Operational decisions may be difficult to follow in the practical applications of the system. Thus, there are activities in the decision model that appear at different levels even though they are actually performed simultaneously. For instance, the adjustment of course programmes and budgets in the annual planning is normally made at the same time as current plans for the individual courses are presented.

The hierarchical models are related to each other through the Model of Decision. Thus each field of decision must be described in terms of its connections to other fields. We recognize three main blocks within which there are strong interconnections between the fields :

A. Undergraduate Technical Education/School (UTE/X)
Graduate Training (GT)
Educational Administration (EA)

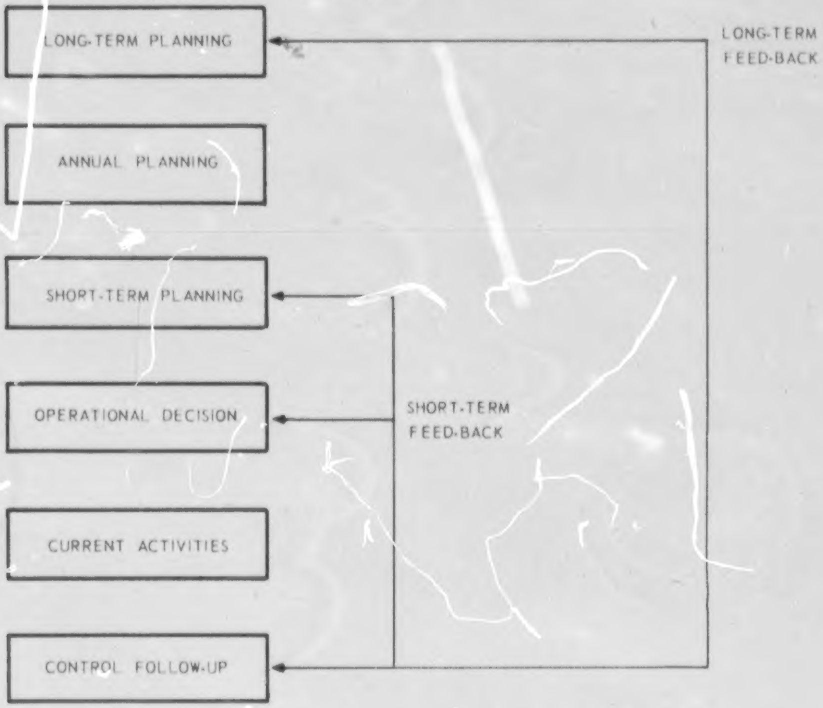
B. Technical Research/Engineering Field (TR/X)
Research Administration (RA)

C. Economy (Ec)
Staff (S)
Planning and Administration of Buildings (PAB)
Planning and Administration of Equipment (PAE)

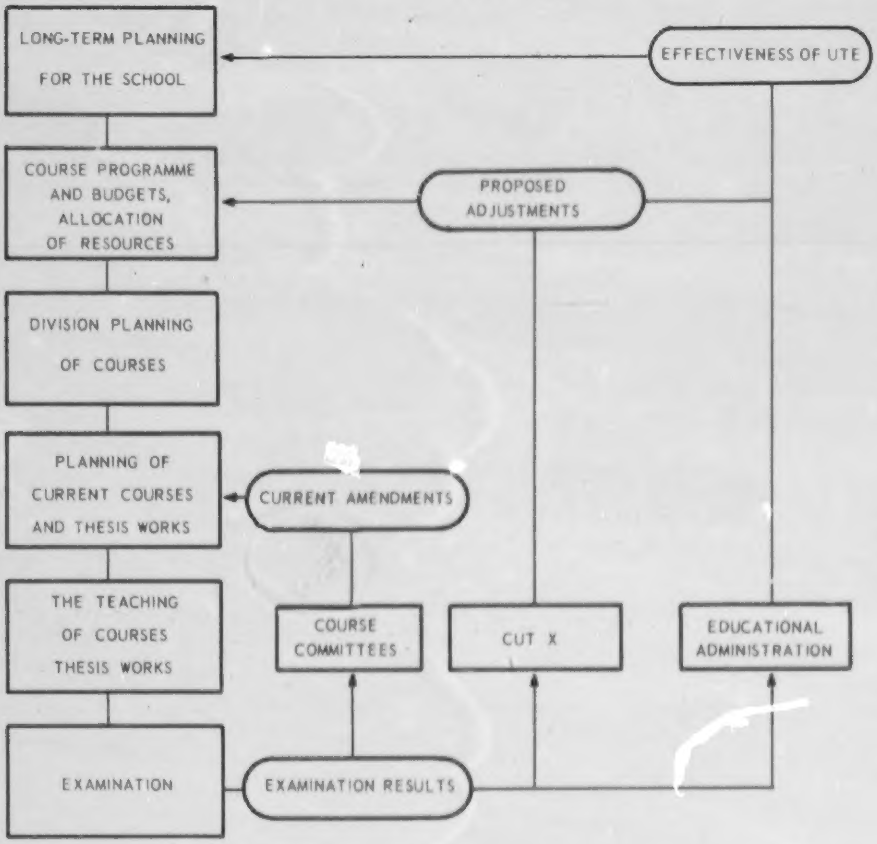
Block C supports the blocks A and B about equally.

The concept of feed-back is an important feature of our information system. The blocks of decision fields generally include two types of feed-back loops :

1. A fast feed-back loop which directly affects the level of performance ;
2. A long-term feed-back process affecting the long-term planning of the decision field (block).


LONG-TERM PLANNING
ANNUAL PLANNING
SHORT-TERM PLANNING
OPERATIONAL DECISION
CURRENT ACTIVITIES
CONTROL FOLLOW-UP
LONG-TERM FEED-BACK
SHORT-TERM FEED-BACK

In terms of these concepts we shall trace the main information procedures described by the hierarchical models. If we look at undergraduate technical education, we distinguish the following structure.


LONG-TERM PLANNING FOR THE SCHOOL
EFFECTIVENESS OF UTE
COURSE PROGRAMME AND BUDGETS, ALLOCATION OF RESOURCES
PROPOSED ADJUSTMENTS
DIVISION PLANNING OF COURSES
PLANNING OF CURRENT COURSES AND THESIS WORKS
CURRENT AMENDMENTS
THE TEACHING OF COURSES THESIS WORKS
COURSE COMMITTEES
CUT X
EDUCATIONAL ADMINISTRATION
EXAMINATION
EXAMINATION RESULTS

Long-term planning is supposed to take into account future qualitative requirements of the graduated engineers, enrolments decided by central authorities and the course of development regarding research and education within the university. The curriculum thus formed and associated plans constitute the basis for the course programmes and the thesis work.

The long-term feed-back is executed through re-allocations to the schools and through changes in the allotment to the individual courses. The committees of education also decide on the number of periods of the courses which is another way of executing the control of the courses.

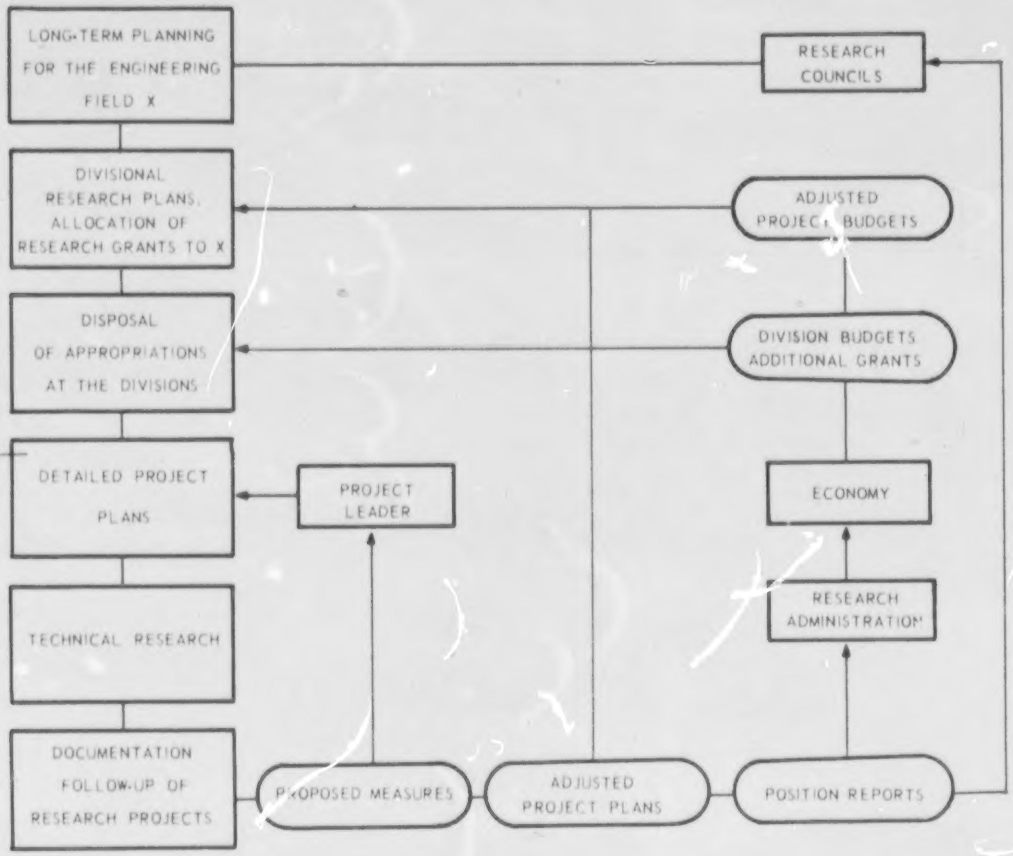
The short-term feed-back in the first place passes through the course committees. These units are supposed to meet before and during the course in question. In this way obvious needs for changes in the teaching can be satisfied immediately. However, changes have to be performed without additional resources.

The graduate training process displays about the same structure as undergraduate technical education. The long-term feed-back in this case involves changes in the additional resources that the divisions receive for current graduate training (scholarships, special GT grants). However, as has been pointed out, it is not possible to control all of the resources for GT, since both UTE and TR support GT activities.

The current adjustments in the GT programme take place at the divisional level and result in changes in individual work programmes and schedules of graduate courses. Of course it is possible to re-allocate research resources between projects in order to support certain GT activities.

Regarding block A the present status of the decision processes corresponds fairly well with our model. The changes that the model requires are primarily some further reports on the output, especially regarding graduate training. As soon as acceptable output measures exist it will be possible to complement the decision process according to the model.

Block B on the other hand displays considerable deviations from the present procedures of research administration. Let us first look at the structure of block B.


LONG-TERM PLANNING FOR THE ENGINEERING FIELD X
RESEARCH COUNCILS
DIVISIONAL RESEARCH PLANS, ALLOCATION OF RESEARCH GRANTS TO X
ADJUSTED PROJECT BUDGETS
DISPOSAL OF APPROPRIATIONS AT THE DIVISIONS
DIVISION BUDGETS ADDITIONAL GRANTS
DETAILED PROJECT PLANS
PROJECT LEADER
ECONOMY
RESEARCH ADMINISTRATION
TECHNICAL RESEARCH
DOCUMENTATION FOLLOW-UP OF RESEARCH PROJECTS
PROPOSED MEASURES
ADJUSTED PROJECT PLANS
POSITION REPORTS

From Chapter 7 we recall that the model assumes that each engineering field is closely related to one of the research councils (including the Board for Technical Development). Long-term feed-back thus means changes that the research councils are continually informed about. The councils decide on the main grants to the engineering fields and on the restrictions regarding the disposition of the grants from final project reports, from progress reports and from national research planning.

Since most research projects at the university cover a considerable range of time we also define the long-term feed-back process within the engineering field at the university. This feed-back passes through the research administration and the economic function and initiates adjusted budgets and plans within the restrictions and grants decided by the councils. Another important feature of the model is the possibility for the university to make additional grants to certain projects or engineering fields, thus forming a research profile of the university. These additional grants should be regarded as an element of the long-term feed-back process.

Current changes continually arise as a research project goes on; especially regarding fundamental research. The scientists make experiences which suddenly give rise to new theories which have to be tested through additional experiments not accounted for in the original plans. It would be useless to prevent scientists from following these impulses. Such changes, therefore, are parts of the short-term feed-back and are decided on by the project leaders. In the case of extensive financial requirements the Committee of Research for the engineering field in question has to be consulted.

Our model for the technical research programmes certainly requires important changes of the present organization within the university. Expert and administrative units will be expected to handle the process described. In section 5 we shall comment on some of the changes in the organization which are suggested in connection with the introduction of the new control and information procedures.

## 4. THE INFORMATION FLOW

In the analysis of the present organization in Chapter 3 we looked upon the relations between central agencies and local units. As is illustrated by diagram 3.7, we require that the central agency gives

- goals
- resources
- restrictions

for the activities to be performed by the local unit. As a basis for decision the central agency on the other hand needs information from the programme area comprising

- achievements
- financial requests
- statement of accounts.

For the purpose of identifying these features in our information system we shall identify eight classes of information.

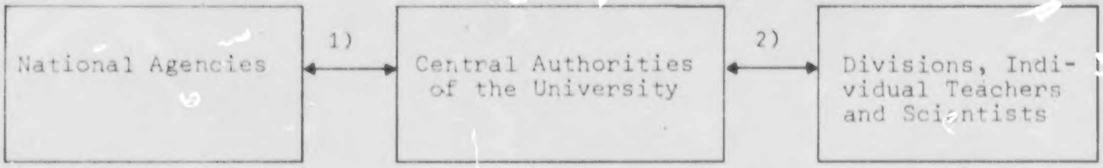
Input information :

$I_A$ Goals and plans
$I_B$ Resources
$I_C$ Restrictions
$I_D$ Administrative systems.

Output information :

$O_A$ Current work, achievements
$O_B$ Financial requests
$O_C$ Statement of accounts
$O_D$ General information about the programme

Since our system of control is characterized by three organizational levels we divided our analysis of the information exchange into two steps illustrated by the diagram below


National Agencies
1)
Central Authorities of the University
2)
Divisions, Individual Teachers and Scientists

Exchange of Information between National Agencies and Central Authorities at the University

The hierarchical models display number of documents passing between the university and the central agencies. Tables 8.1 and 8.2 give an overview of these reports with respect to the classes of information defined above.

Table 8.1.

INPUT INFORMATION TO THE UNIVERSITY

| Decision Process | | Document of information | Control Agency | Class of information | | | |
|---|---|---|---|---|---|---|---|
| Field | Code | | | $I_A$ | $I_B$ | $I_C$ | $I_D$ |
| UTE/X | 1 X 1 | National goals for UTE | OCU | $I_A$ | | | |
| | 1 X 23 | RRL for UTE | G | | $I_B$ | $I_C$ | |
| GT | 2011 | National goals for GT | OCU | $I_A$ | | | |
| | 2022 | RRL for GT | G | | $I_B$ | $I_C$ | |
| | 2021 | Admission rules | OCU | | | $I_C$ | |
| TR/X | 3 X 1 | National research goals | RC (2) | $I_A$ | | | |
| | 3 X 22 | TRX grants | RC (2) | | $I_B$ | $I_C$ | |
| | 3 X 4 | Commission Contracts | CC | | $I_B$ | $I_C$ | |
| Ec,S | 414 | SEA-system | NAB | | | | $I_D$ |
| | 4261 | | | | | | |
| | 422 | New offices | G | | $I_B$ | | |
| EA | 511 | Student admission, UTE | OCU | | | $I_C$ | |
| | 515 | Grade register system | | | | | $I_D$ |
| | 516 | Operational goals for UTE and GT | OCU | $I_A$ | | | |
| RA | 5251 | Commission contracts | CC | | $I_B$ | $I_C$ | |
| PAB | 531 | Max. grants for buildings | G | | $I_B$ | | |
| | 532 | Detailed building plans | KBS | | | $I_C$ | |
| | | Rules for allotment of space | OCU | | | $I_C$ | |
| | 533 | System for registration of space resources (1) | OCU | | | | $I_D$ |
| PAE | 541 | Max. grants for investments | G | | $I_B$ | | |
| | 542 | Max. grants for specific equipment objects | UUH | | | $I_C$ | |
| | | System for registration of equipment (1) | | | | | $I_D$ |

1) System for registration of spaces and equipment are not yet available.

2) Including Board for Technical Development.

Table 8.2

OUTPUT INFORMATION FROM THE UNIVERSITY

| Decision Process | | Document of information | Control Agency | Class of information | | | |
|---|---|---|---|---|---|---|---|
| Field | Code | | | $O_A$ | $O_B$ | $O_C$ | $O_D$ |
| TR/X | 3 X 6 | Research reports | RC | $O_A$ | | | $O_D$ |
| Ec | 411 | [illegible]-Proposition, CTH | OCU<br>RC<br>KBS<br>UUH | $O_A$ | $O_B$ | | |
| | 416 | Final balance, CTH | NAB | | | $O_C$ | |
| EA | 512 | Course Catalogue, UTE | | | | | $O_D$ |
| | | Education Catalogue, GT | | | | | $O_D$ |
| | | Effectiveness, UTE and GT | OCU | $O_A$ | | | |
| RA | 522 | Project Catalogue | | | | | $O_D$ |
| | | Effectiveness, TR | RC | $O_A$ | | | |
| PAB | 531 | Building programme | KBS | | $O_B$ | | |
| | 532 | Building disposition plan | | | | | $O_D$ |
| | 533 | Room schedule | | | | | $O_D$ |
| | | Position reports are current | KBS | $O_A$ | | | |
| PAE | 541 | Equipment programme | UUH | | $O_B$ | | |
| | 543 | Equipment capacity plan | | | | | $O_D$ |
| | 5461 | Deviations from plans | UUH | $O_A$ | | | |

An important feature of the system is that most of the input information is directly passed to the main programme while the corresponding output information is produced by the auxiliary functions Ec, EA and RA. The objective is to relieve the scientists as far as possible from the administrative tasks regarding financial and other follow-up reports.

From the tables above we recognize the correspondence between input and output information. The central agency granting the resources and making up the goals is also the main recipient of output reports from the programme level. This is especially apparent regarding the research programme. We illustrate the exchange of information for this programme by describing the classes of information.

Information exchange of TR/X

$I_A$ The research council which is in charge of the research field works out a national research plan showing current and planned research activities at different institutes. This plan (or a fraction of the plan) goes to the Committee of Research of the field in question at the university.

$I_B$ In accordance with the plans the research councils grant necessary resources to the field of research.

$I_C$ In connection with the grants RC formulates rules and restrictions on how the resources are to be used. Thus there will be general principles for the allotment of resources to the divisions. Further the research councils will be expected to specify certain projects to be performed and to give the financial limitations of these projects.

$I_D$ The research activities are managed by the SEA-system and there will be no need for any extra administrative system for research administration.

$O_A$ The research reports are the most apparent output documents of the research programme. An overview of the performance within each research field follows the PB-proposition. As a basis for planning and giving priorities it will be necessary to have some measure of effectiveness. Eventually effects must be confined to the extent to which given plans are fulfilled (cf. Chapter 6).

$O_B$ Each field of research presents a budget request including plans and financial requirements. The research councils receive this request together with the other requests of the PB-proposal.

[illegible]$_C$ For each project there will be a statement of accounts presented at the end of the fiscal period. These matters are all administered by the economy function.

$O_D$ As general information for the industry and the public and also for other divisions at the university, the university research administration publishes a research catalogue which is a review of current projects. In this catalogue references are made to available reports.

Exchange of Information between Central Units at the University and the Divisions

From the point of view of the university the internal flow of information is considerably more complex than the external exchange of information presented in the preceding paragraph. Obviously the character of the information should be the same as for external information. However, at the university level it is not always clear at what level the responsibility of deicision actually is to be found.

With regard to undergraduate and graduate training our information system to a great extent displays the present channels of information. Most of the documents are already in current use. Future work in this area will be concerned about the technical problems of integrating the different reports, e.g. the aggregation of course budgets into budgets for the schools. Further there is a need for operational tools at the different levels in order to facilitate the choice of strategy within the decision processes.

The hierarchical models should be looked upon as a proposed system of reports that we consider necessary for a satisfactory control of activities. It is important to check that our classes of information are well represented in the exchange of information between central units and individual divisions. Table 8.3 gives an overview of the documents concerning the research programme which circulate among the auxiliary functions, the committee of research X and the subordinated divisions. In this case we do not take into account plans and reports passed on within the division. Nor do we bother about information passed on to the central committee of research.

We shall comment briefly on the different reports. The *project time report* emanates from the SEA-system and gives the time devoted to different projects. It also displays the relationship between planned and utilized time. Thus it represents a constraint, that is, it reveals how much time is available for each project.

*The adjusted project plans* are the result of the follow-up process. They give the actual available time and current goals of the project work. The plans are complemented by the *adjusted project budgets* showing the financial framework of the project.

*The adjusted division budget* is the result of the project budgets, course budgets, etc., after the central board has made the necessary cuts.

An important feature of the model is the possibility for the university to initiate its own projects and to support certain external projects which do not receive enough support from the research councils and which are in urgent need for more resources. These appropriations, passed by the central committee of research, are represented by "*Additional research grants*" and by "*Project plans, CTH-projects*".

The division receives *personnel ledger* and *cost accounting* from the staff and economy functions. These reports are distributed regularly, e.g. monthly, and are supposed to give the division an idea of the status of personnel and of the accounts.

When we look at the output information from the division we recognize that there is no document representing class $O_C$, statement of account. This certainly follows from the fact that all accounting services are executed

Table 8.3

INFORMATION EXCHANGE OF THE RESEARCH PROGRAMME

| Decision Process | | Documents of information | Class of information | | | |
|---|---|---|---|---|---|---|
| Code | Process | | $I_A$ | $I_B$ | $I_C$ | $I_D$ |
| INPUT | | | | | | |
| 3 X 21 | Planning of Division Research | Project time reports | | | $I_C$ | |
| | | Adjusted project plans | $I_A$ | | | |
| | | Adjusted project budgets | | $I_B$ | | |
| 3 X 3 | Disposal of Research | Adjusted division budgets | | $I_B$ | | |
| | | Personnel ledger | | | $I_C$ | |
| | | Additional research grants | | $I_B$ | | |
| 3 X 4 | Detailed Planning of Projects | | | | | |
| 3 X 5 | Technical Research | Project plans, CTH-projects | $I_A$ | | | |
| | | Cost Accounting | | | $I_C$ | |
| | | Commission Contracts | $I_A$ | $I_B$ | $I_C$ | |
| | | | Class of information | | | |
| OUTPUT | | | $O_A$ | $O_B$ | $O_C$ | $O_D$ |
| 3 X 21 | Planning of Division Research | Division Research Plan | $O_A$ | | | $O_D$ |
| 3 X 3 | Disposal of Research | Request/excess of research workers | | $O_B$ | | |
| | | Report or purchased equipment | | | | $O_D$ |
| 3 X 4 | Detailed Planning of Projects | Project change reports | $O_A$ | | | |
| 3 X 6 | Reporting | Position reports | $O_A$ | | | |

by the economy function. It should not be necessary for the division to produce its own statement of accounts.

The most important output information to the local control unit are the reports on the status of the projects. The division research plan shows the financial and time limitations of the projects. The project change report is supposed to announce change in the original or current project plan. The position report is intended to be a regular document just stating the progress of the project with respect to the current plan and budget.

Of course most of the documents of information of the hierarchical models have to be made short and simplified. Special forms will be developed for this purpose (cf. the division budget form, Appendix IIB, Table 8). It is important that in due time the information system gives warning signals when there are serious deviations from original plans. In order to achieve this it is important to keep the volume of regular information as small as possible. Our outline of an information system hopefully constitutes a basis for developing a reasonable number of regular documents of information.

## 5. CONCLUSIONS

The preceding paragraph outlines a possible information system for higher education and research at a technical university. The responsibility for decisions is divided into eight fields of decision out of which three represent the main programmes; undergraduate technical education, graduate training and technical research. In fact each school of education and each field of technical research represents a field of decision. The remaining five fields constitute economic and administrative functions. Within each field of decision we define a hierarchy ranging from long-term planning to control and follow-up.

One should observe that we have made little reference to the underlying organization. The information system is based on the organization model presented in Chapter 7 and like this model the system emanates from the present organization given in Chapter 3 and from the results of our investigations, interviews and discussions. Thus there are some features of the information system that require re-organization and new organizational units. We shall analyze some of the consequences on the present organization in this section.

1. Our model does not at this point suggest any changes regarding undergraduate technical education. We rather try to strengthen the distinction between producing units and consuming units - the schools. The schools are given the resources out of which they are expected to fulfil certain educational goals by means of courses and some special activities like thesis work.

2. Graduate training is regarded as an isolated programme, however, strongly connected to the research programme. Like former reports

we point out the need for long-term planning and control of graduate training. Such activities are under development in the present organization. We anticipate this development but confine the programme to additional resources that are not provided by the other main programmes. The Central Committee of Graduate Training is to be responsible for the long-term planning and for the allocation of these additional resources (scholarships, travel expenses, graduate courses and examination costs).

3. With respect to the research programme our system results in a decentralization of the decisions on allocation from the national level to the university level. Even though the research resources (as today) will be directly allocated to individual projects, the basic resources provided by the research councils will have to be allotted by a responsible unit at the university. We anticipate further a development toward the university forming its own research profile through initiation of new projects and through conscious support through the research grants of especially urgent research fields.
4. On the other hand the individual scientists will experience a centralization of the decisions to certain officials at the university who will be representatives of the deciding boards. This decentralization requires a formal organization at the university with the responsibility of planning and appropriations. We suggest that the University Board remains formally responsible for the research profile, the special "CTH-projects" and the appropriation of resources. However, before being confirmed by the University Board the research issues will be handled by the Central Committee of Research. Further there will be one committee of research for each technical research field. This committee will be expected to communicate with the corresponding research council. The administrative tasks in connection with planning and allocations are to be handled by a unit for research planning and should take care of the activities of this field of decision.

5. Beyond working out the basis for decisions, we suggest that the research planning unit handles information about current research at the university - information to scientists inside and outside the university. This means that the present information and intermediation secretariat will be a part of the planning unit. Further, the unit is to offer services such as external contacts, judicial problems of contracts, patents, etc., to the scientists.

6. A special planning section will have to be responsible for space and equipment covered by the corresponding fields of decision. This will be more apparent when systems for registration of space and equipment are available. At that point the information system provides for an efficient utilization of two very important types of resources.

7. The information system is characterized by a rather clear subdivision of different types of tasks. Thus the main programme fields are to be mainly concerned with educational and scientific problems in connection with planning. Pure administrative tasks of putting pieces of information together, budget work, follow-up of statements of accounts, etc., belong to the auxiliary functions where scientists and teachers are supposed to play a minor part. Of course all of the economic and administrative activities do not take part in one central unit. Certain administrative resources have to be available at the divisional level. However, the idea of the economic and staff fields of decision is that the administrative system is strongly tied together in order to facilitate the communication between the different parts of the system. Thus the central administrative unit of the university is to be responsible for information to and training of the administrative staff.

8. The volume of information can be expected to increase due to the suggested system. This is not desirable. However, we anticipate a reduced exchange of irrelevant information between central agencies and the university. The essence of the information from the university will be built into the Programme Budget Proposal. In the opposite direction we have the Royal Regulation Letter regarding higher education and the research grants and national research plans from the research councils. If we look at the internal flow of information, the future development of the system will be centered around the problem of circulating efficient information relevant to the decisions to be made. In the case where the computer systems are involved, these systems will have to be adapted to the needs of the central units. The goal of the information system is that "the right kind of information shall be available in due time at the right place" but also that the documents of information are easy to produce and to consume.

9. The decision model presented is a static one. It does not take into account the times required to produce the different documents.

The precedence relations have to be further analyzed with respect to time precision. These problems are problems of developing an integrated information system. The first step will be to analyze the different decision processes with respect to goals and the need for information. At the end of this step it will be possible to define decisions as well as necessary documents. Secondly, network planning takes care of the co-ordination of the different pieces of information with respect to time. We feel that the decision model may act as a possible basis for this analysis.

Appendix I

## UNDERGRADUATE TECHNICAL EDUCATION (UTE)

Table 1 (a)

TOTAL STUDENT COSTS

1968/69

ThSwCr

| | School | | | | | | Total/ Average |
|---|---|---|---|---|---|---|---|
| | Ph | M | E | C | Ch | A | |
| Total costs | 3,136 | 5,079 | 6,352 | 5,381 | 3,738 | 2,540 | 26,226 |
| Total costs % | 12.0 | 19.4 | 24.2 | 20.5 | 14.2 | 9.7 | 100.0 |
| Nom. number of stud. | 215 | 726 | 755 | 680 | 270 | 240 | 2,886 |
| Total costs/stud. | 14.6 | 7.0 | 8.4 | 7.9 | 13.8 | 10.6 | 9.2 |

1969/70

ThSwCr

| | School | | | | | | Total/ Average |
|---|---|---|---|---|---|---|---|
| | Ph | M | E | C | Ch | A | |
| Total costs | 3,454 | 5,652 | 6,908 | 5,965 | 4,083 | 2,746 | 28,808 |
| Total costs % | 12.0 | 19.6 | 24.0 | 20.7 | 14.2 | 9.5 | 100.0 |
| Nom. number of stud. | 240 | 738 | 770 | 680 | 295 | 240 | 2,963 |
| Total costs/stud. | 14.4 | 7.7 | 9.0 | 8.8 | 13.8 | 11.4 | 9.7 |

1970/71

ThSwCr

| | School | | | | | | Total/ Average |
|---|---|---|---|---|---|---|---|
| | Ph | M | E | C | Ch | A | |
| Total costs | 3,092 | 6,627 | 7,219 | 6,388 | 3,866 | 2,937 | 30,129 |
| Total costs % | 10.3 | 22.0 | 24.0 | 21.2 | 12.8 | 9.7 | 100.0 |
| Nom. number of stud. | 240 | 750 | 785 | 680 | 320 | 240 | 3,015 |
| Total costs/stud. | 12.9 | 8.8 | 9.2 | 9.4 | 12.1 | 12.2 | 10.0 |

Table 1 (b)

MEDIAL TIME OF STUDY FOR STUDENTS

REGISTERED IN 1964

Years

| | School | | | | | | Average |
|---|---|---|---|---|---|---|---|
| | Ph | M | E | C | Ch | A | |
| Medial time of study | 4.1 | 4.4 | 4.9 | 4.3 | 4.3 | 4.9 | 4.4 |

Table 1 (c)

TOTAL COSTS PER GRADUATE STUDENT

ThSwCr

| | School | | | | | | Average |
|---|---|---|---|---|---|---|---|
| | Ph | M | E | C | Ch | A | |
| Total costs/ stud. | 59.9 | 35.9 | 45.4 | 39.0 | 59.6 | 58.5 | 49.7 |

Total student hours comprise 50 hours per week and 40 weeks work per student and year. Scheme hours comprise only 30 hours per week. Teacher hours includes total costs for undergraduate technical education, even administration of courses, hence not only time in class. The time is calculated on basis of 8 hours per man-day. Full-time equivalent teachers is calculated according to 200 man-days per person and year.

Table 1 (d)

STUDENT/FACULTY RATIO

1970/71

| | School | | | | | | CTH |
|---|---|---|---|---|---|---|---|
| | Ph | M | E | C | Ch | A | |
| Total student hours/teacher hour | 7.5 | 12.3 | 12.3 | 10.9 | 7.1 | 8.0 | 10.2 |
| Scheme hours/ teacher hour | 4.5 | 7.4 | 7.4 | 6.5 | 4.3 | 4.8 | 6.1 |
| Number of students/FTE teacher | 6.0 | 9.9 | 9.8 | 8.7 | 5.7 | 6.3 | 8.2 |

## GRADUATE TRAINING (GT)

### Table 2 (a)

### TOTAL COSTS PER GRADUATE STUDENT

1970/71

ThSwCr

| | Department | | | | | | | Total Average |
|---|---|---|---|---|---|---|---|---|
| | Ph.math. | Ph.phys. | M | E | C | Ch | A | |
| Tot.costs for GT | 1,269 | 1,508 | 1,785 | 2,712 | 1,155 | 1,963 | 491 | 10,883 |
| Number of grad.stud. | 65 | 140 | 129 | 104 | 51 | 218 | 35 | 742 |
| Tot.costs/ grad.stud. | 19.5 | 10.8 | 13.8 | 26.1 | 22.6 | 9.0 | 14.0 | 14.7 |

### Table 2 (b)

### TOTAL COSTS FOR RESEARCH AND GRADUATE TRAINING PER GRADUATE STUDENT

ThSwCr

| | 1968/69 | 1969/70 | 1970/71 |
|---|---|---|---|
| Tot.costs for research and GT | 37,583 | 41,317 | 45,064 |
| Number of grad.stud. | 567 | 706 | 742 |
| Tot.costs/grad.stud. | 66.3 | 58.5 | 60.7 |

### Table 2 (c)

### TOTAL COSTS PER FTEGS

1970/71

ThSwCr

| | Department | | | | | | | Total/ Average |
|---|---|---|---|---|---|---|---|---|
| | Ph.math. | Ph.phys. | M | E | C | Ch | A | |
| Tot.costs for GT | 1,269 | 1,508 | 1,785 | 2,712 | 1,155 | 1,963 | 491 | 10,883 |
| FTE number of grad.stud. | 37.5 | 76.5 | 69.0 | 58.0 | 26.5 | 117.5 | 19.0 | 404.0 |
| Tot.costs/ FTEGS | 33.8 | 19.7 | 25.9 | 46.8 | 43.6 | 16.7 | 25.8 | 26.9 |

## Table 2 (d)

## NUMBER OF GRADUATE STUDENTS STANDARDIZED 1970/71

| Department | Graduate students |  |  |  |  |  | Total |  |
|---|---|---|---|---|---|---|---|---|
|  | Scholarship |  | Assistant |  | Others |  |  |  |
|  | Number | FTE number | Number | FTE number | Number | FTE number | Number | FTE number |
| Ph. math. | 10 | 10.0 | 34 | 17.0 | 21 | 10.5 | 65 | 37.5 |
| Ph. phys. | 13 | 13.0 | 45 | 22.5 | 82 | 41.0 | 140 | 76.5 |
| M | 9 | 9.0 | 59 | 29.5 | 61 | 30.5 | 129 | 69.0 |
| E | 12 | 12.0 | 55 | 27.5 | 37 | 18.5 | 104 | 58.0 |
| C | 2 | 2.0 | 34 | 17.0 | 15 | 7.5 | 51 | 26.5 |
| Ch. | 17 | 17.0 | 101 | 50.5 | 100 | 50.0 | 218 | 117.5 |
| A | 3 | 3.0 | 19 | 9.5 | 13 | 6.5 | 35 | 19.0 |
| Total | 66 | 66.0 | 347 | 173.5 | 329 | 164.5 | 742 | 404.0 |

## Table 2 (e)

## PASSED EXAMINATIONS

|  | Number of graduate students | Number of passed exams | Exam % |
|---|---|---|---|
| 1967/68 | 314 | 61 | 19.4 |
| 1968/69 | 328 | 59 | 18.0 |
| 1969/70 | 470 | 73 | 15.5 |
| Average | 371 | 64 | 17.3 |

## Table 2 (f)

## NUMBER OF GRADUATE STUDENTS PER SUPERVISOR

1969/70

|  | Department |  |  |  |  |  | Total/ Average |
|---|---|---|---|---|---|---|---|
|  | Ph | M | E | C | Ch | A |  |
| Number of supervisors | 32 | 17 | 18 | 15 | 22 | 9 | 113 |
| Number of grad. stud. | 229 | 97 | 81 | 67 | 212 | 20 | 706 |
| Grad.stud/Supervisor | 7.2 | 5.7 | 4.5 | 4.5 | 9.6 | 2.2 | 6.2 |

1970/71

|  | Department |  |  |  |  |  |  | Total/ Average |
|---|---|---|---|---|---|---|---|---|
|  | Ph.math. | Ph.phys. | M | E | C | Ch | A |  |
| Number of supervisors | 14 | 23 | 20 | 20 | 16 | 27 | 8 | 128 |
| Number of grad. stud. | 65 | 140 | 129 | 104 | 51 | 218 | 35 | 742 |
| Grad. stud/supervisor | 4.6 | 6.1 | 6.5 | 5.2 | 3.2 | 8.1 | 4.4 | 5.8 |

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## Table 2 (g)

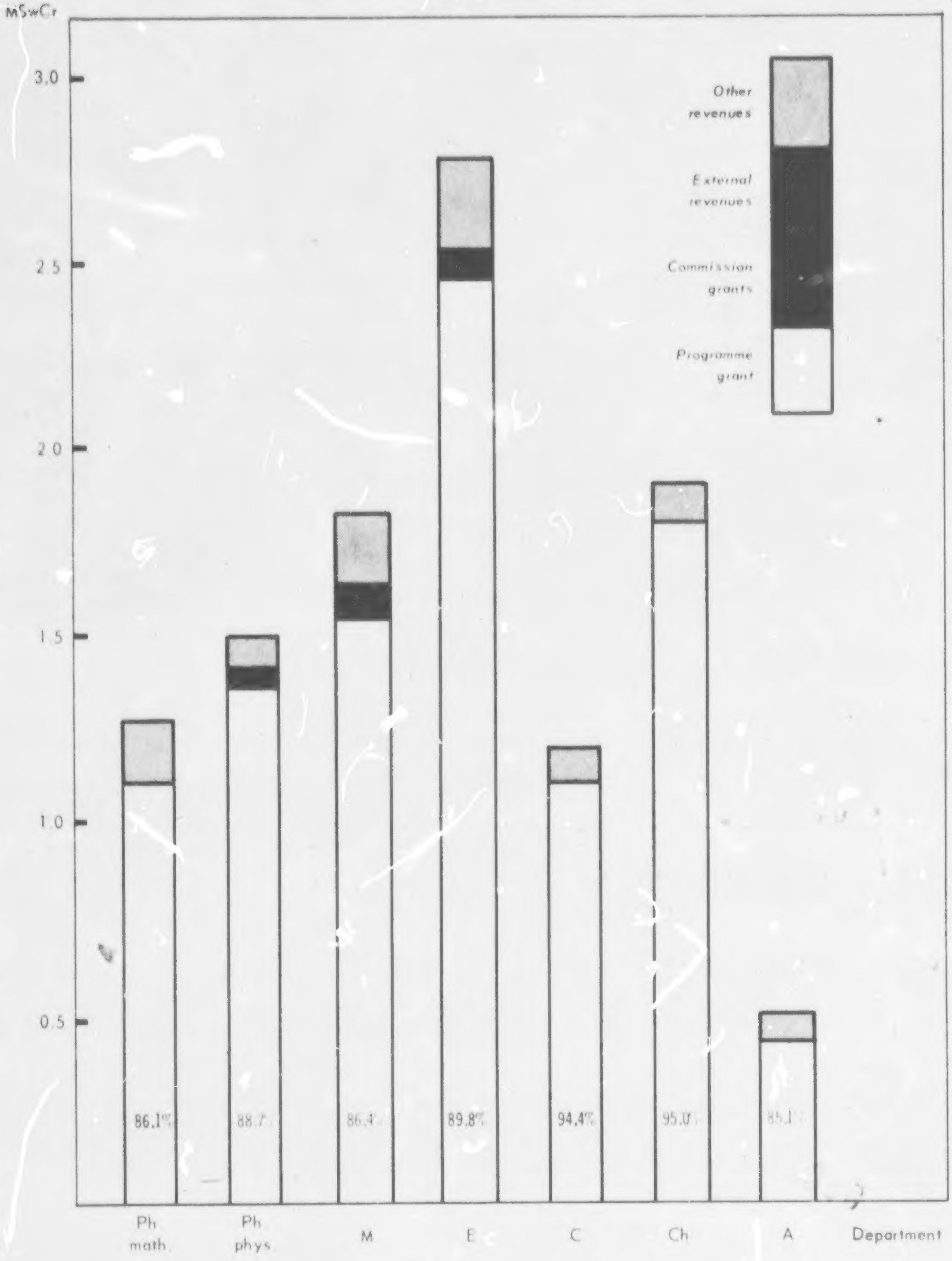
## STRUCTURE OF COSTS OF GRADUATE TRAINING 1970/71

ThSwCr

| Type of costs | Department | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | Ph.math. | Ph.phys. | M | E(incl.Space Observatory) | C | Ch | A | |
| I. Total direct costs | 1157 | 1375 | 1628 | 2473 | 1053 | 1791 | 448 | 9925 |
| II. Total indirect costs | 112 | 133 | 157 | 239 | 102 | 172 | 43 | 958 |
| I+II. Total costs | 1269 | 1508 | 1785 | 2712 | 1155 | 1963 | 491 | 10883 |
| BTD | | | 71 | 50 | | | | 121 |
| NRC | | | | | | | | |
| ARC | | 24 | | | | | | 24 |
| BRC | | | | | | | | |
| Agency of Traffic Safety | | | | | | | | |
| Agency of Preservation of Nature | | | | | | | | |
| Remaining councils and foundations | | | | 6 | | | | 6 |
| Commission revenues | | 14 | | | | | | 14 |
| III. External revenues | | 38 | 71 | 56 | | | | 165 |
| Doctorate scholarships | 13 | 85 | 68 | 100 | 21 | 61 | 28 | 376 |
| Computer time | 133 | | 61 | 80 | | | 25 | 299 |
| Special grants for graduate training | 12 | 25 | 17 | | 27 | 10 | 13 | 104 |
| Building service | 18 | 22 | 26 | 40 | 17 | 28 | 7 | 158 |
| IV. Other revenues | 176 | 132 | 172 | 220 | 65 | 99 | 73 | 937 |
| V. Programme grant | 1093 | 1338 | 1542 | 2436 | 1090 | 1864 | 418 | 9781 |

Figure 1

FINANCING STRUCTURE OF DEPARTMENTS 1970/71
GRADUATE TRAINING



## RESEARCH (B)

### Table 3 (a)

### COSTS PER SCIENTIST (1) 1970/71

ThSwCr

| | Department | | | | | | | Total/ Average |
|---|---|---|---|---|---|---|---|---|
| | Ph.math. | Ph.phys. | M | E | C | Ch | A | |
| Total costs | 1,065 | 6,852 | 4,075 | 5,835 | 5,174 | 10,010 | 1,287 | 34,298 |
| Number of scientists | 14 | 23 | 20 | 20 | 16 | 27 | 8 | 128 |
| Costs/scientist | 76.1 | 297.9 | 203.8 | 291.8 | 323.4 | 370.7 | 160.9 | 268.0 |

### Table 3 (b)

### COSTS PER SCIENTIST (1) MAN-DAYS RESEARCH 1970/71

ThSwCr

| | Department | | | | | | | Total/ Average |
|---|---|---|---|---|---|---|---|---|
| | Ph.math. | Ph.phys. | M | E | C | Ch | A | |
| Total costs | 1,065 | 6,852 | 4,075 | 5,835 | 5,174 | 10,010 | 1,287 | 34,298 |
| Scientist man-days | 932 | 1,970 | 1,302 | 904 | 895 | 2,945 | 883 | 9,568 |
| Costs/man-days | 1.1 | 4.0 | 3.1 | 6.5 | 5.8 | 3.4 | 1.5 | 3.6 |

### Table 3 (c)

### COSTS PER SCIENTIST (1) GRADUATE TRAINING 1970/71

ThSwCr

| | Department | | | | | | | Total/ Average |
|---|---|---|---|---|---|---|---|---|
| | Ph.math. | Ph.phys. | M | E | C | Ch | A | |
| Total costs | 1,269 | 1,508 | 1,785 | 2,712 | 1,155 | 1,963 | 491 | 10,883 |
| Scientist man-days | 1,181 | 577 | 685 | 1,599 | 625 | 1,345 | 189 | 6,464 |
| Costs/man-days | 1.1 | 1.8 | 2.6 | 1.7 | 1.8 | 1.5 | 2.6 | 1.7 |

### Table 3 (d)

### COSTS PER SCIENTIST (1) RESEARCH AND GRADUATE TRAINING 1970/71

ThSwCr

| | Department | | | | | | | Total/ Average |
|---|---|---|---|---|---|---|---|---|
| | Ph.math. | Ph.phys. | M | E | C | Ch | A | |
| Total costs | 2,334 | 8,360 | 5,860 | 8,547 | 6,329 | 11,973 | 1,778 | 45,181 |
| Scientist man-days | 2,113 | 2,547 | 1,987 | 2,503 | 1,52 | 4,290 | 1,072 | 16,032 |
| Costs/man-days | 1.1 | 3.3 | 2.9 | 3.4 | 4.2 | 2.8 | 1.7 | 2.8 |

1) The concept "scientist" in this report only includes the higher offices - professor, associate professor, assistant professor, professor and research assistant.

Table 3 (e)

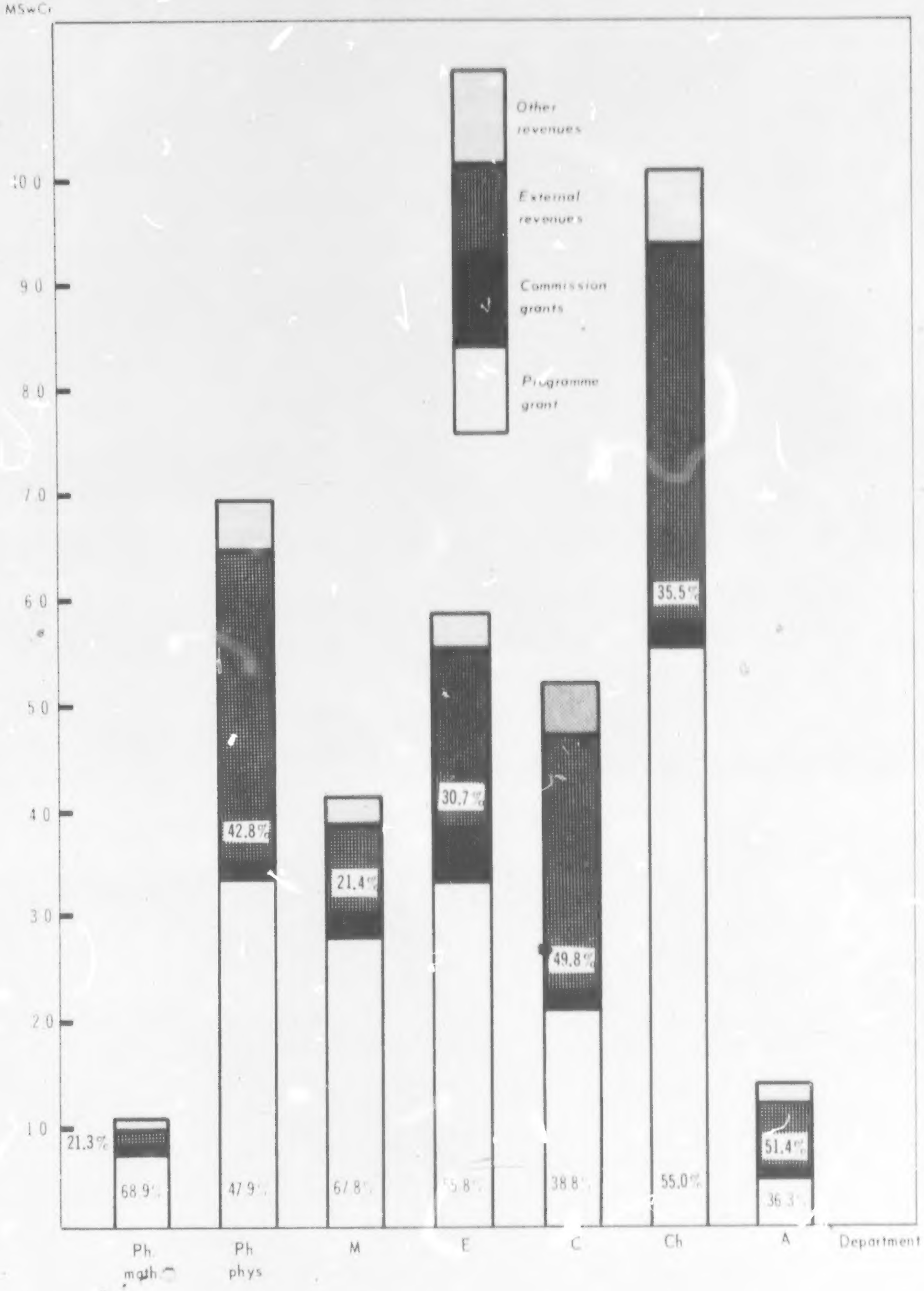
STRUCTURE OF COSTS OF RESEARCH 1970/71

ThSwCr

| Type of costs | Department | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | Ph. math. | Ph. phys. | M | E(incl.Space Observatory) | C | Ch | A | |
| I. Total direct costs | 972 | 6,249 | 3,716 | 5,322 | 4,718 | 9,129 | 1,175 | 31,281 |
| II. Total indirect costs | 93 | 603 | 359 | 513 | 456 | 881 | 112 | 3,017 |
| I+II. Total costs | 1,065 | 6,852 | 4,075 | 5,835 | 5,174 | 10,010 | 1,287 | 34,298 |
| BTD | 55 | 778 | 874 | 1,694 | 261 | 1,503 | | 5,165 |
| NRC | 48 | 682 | | | | 566 | | 1,296 |
| ARC | | 1,474 | | | | 440 | | 1,914 |
| BRC | | | | | 2,195 | | 311 | 2,506 |
| Agency of Traffic Safety | | | | | | | 350 | 350 |
| Agency of Preservation of Nature | | | | | 120 | 170 | | 290 |
| Remaining councils and foundations | 124 | | | 97 | | 871 | | 1,092 |
| Commission revenues | 20 | 141 | 211 | 510 | 127 | 261 | 40 | 1,310 |
| III. External revenues | 247 | 3,075 | 1,085 | 2,301 | 2,703 | 3,811 | 701 | 13,923 |
| Doctorate scholarships | | | | | | | | |
| Computer time | 46 | 396 | 169 | 194 | 400 | 550 | | 1,755 |
| Special grants for graduate training | | | | | | | | |
| Compensations | 23 | | | | | | 100 | 123 |
| Building service | 15 | 100 | 60 | 85 | 77 | 145 | 19 | 501 |
| IV. Other revenues | 84 | 496 | 229 | 279 | 477 | 695 | 119 | 2,379 |
| V. Programme grant | 734 | 3,281 | 2,761 | 3,255 | 1,994 | 5,504 | 467 | 17,996 |

Figure 2

## FINANCING STRUCTURE OF DEPARTMENTS 1970/71
## TECHNICAL RESEARCH



## RELATIONS BETWEEN THE MAIN PROGRAMMES

### Table 4 (a)

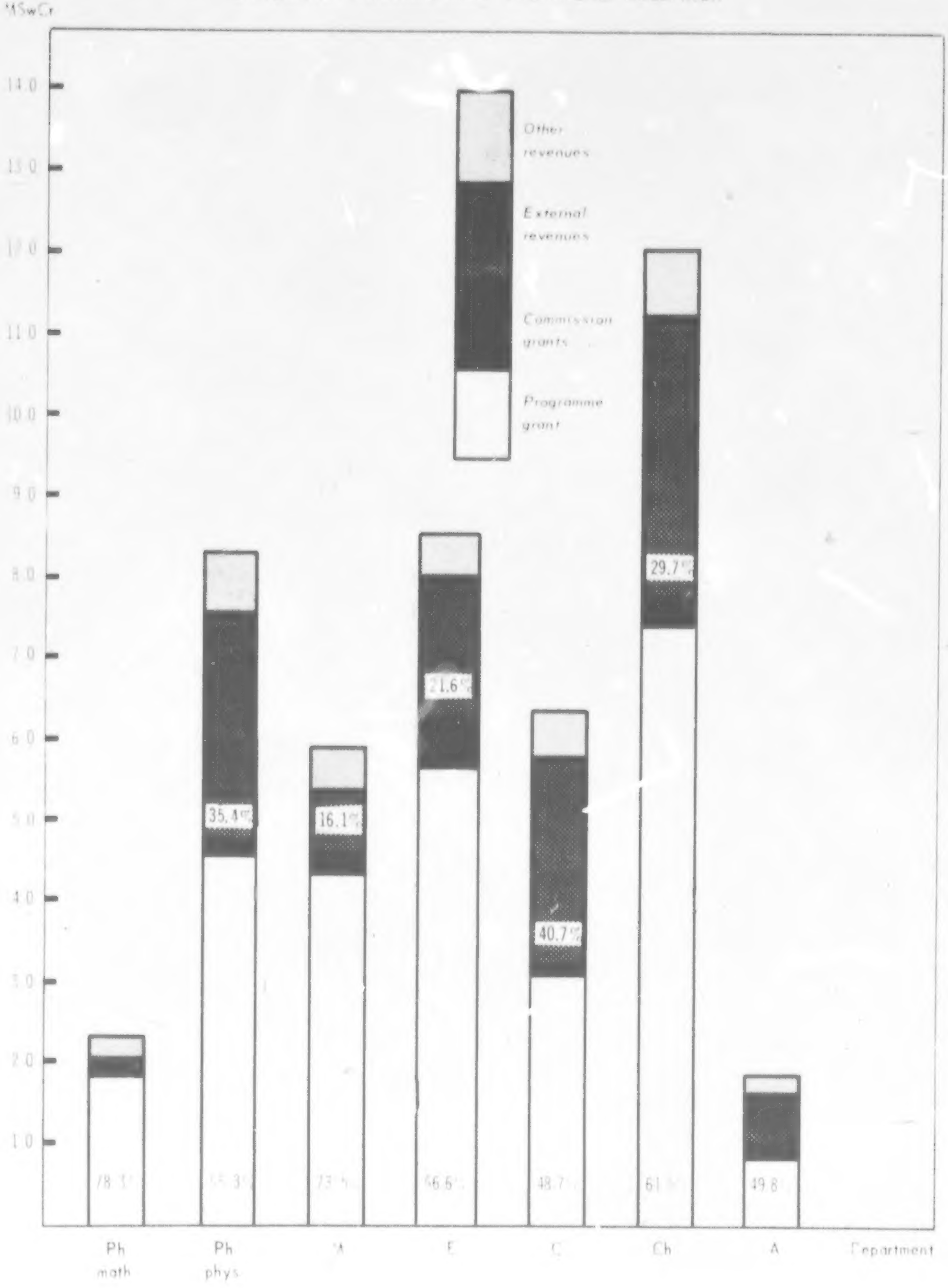
### STRUCTURE OF COSTS FOR RESEARCH AND GRADUATE TRAINING 1970/71

ThSwCr

| Type of costs | Department | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | Ph. math. | Ph. phys. | M | E (incl. Space Observatory) | C | Ch | A | |
| I. Total direct costs | 2,129 | 7,624 | 5,344 | 7,795[1] | 5,771 | 10,920 | 1,623 | 41,206 |
| II. Total indirect costs | 205 | 736 | 516 | 752 | 558 | 1,053 | 155 | 3,975 |
| I+II. Total costs | 2,334 | 8,360 | 5,860 | 8,547 | 6,329 | 11,973 | 1,778 | 45,181 |
| BTD | 55 | 778 | 945 | 1,744 | 261 | 1,503 | | 5,286 |
| NRC | 48 | 682 | | | | 566 | | 1,296 |
| ARC | | 1,498 | | | | 440 | | 1,938 |
| BRC | | | | | 2,195 | | 311 | 2,506 |
| Agency of Traffic Safety | | | | | | | 350 | 350 |
| Agency of Preservation of Nature | | | | | 120 | 170 | | 290 |
| Remaining councils and foundations | 124 | | | 103 | | 871 | | 1,098 |
| Commission revenues | 20 | 155 | 211 | 510 | 127 | 261 | 40 | 1,324 |
| III. External revenues | 247 | 3,113 | 1,156 | 2,357 | 2,703 | 3,811 | 701 | 14,088 |
| Doctorate scholarships | 13 | 85 | 68 | 100 | 21 | 61 | 28 | 376 |
| Computer time | 179 | 396 | 230 | 274 | 400 | 550 | 25 | 2,054 |
| Social grants for graduate training | 12 | 25 | 17 | | 27 | 10 | 13 | 104 |
| Building service | 33 | 122 | 86 | 125 | 94 | 173 | 26 | 659 |
| Compensation | 23 | | | | | | 100 | 123 |
| IV. Other revenues | 260 | 628 | 401 | 499 | 542 | 794 | 192 | 3,316 |
| V. Programme grant | 1,827 | 4,619 | 4,303 | 5,691 | 3,084 | 7,368 | 885 | 27,777 |

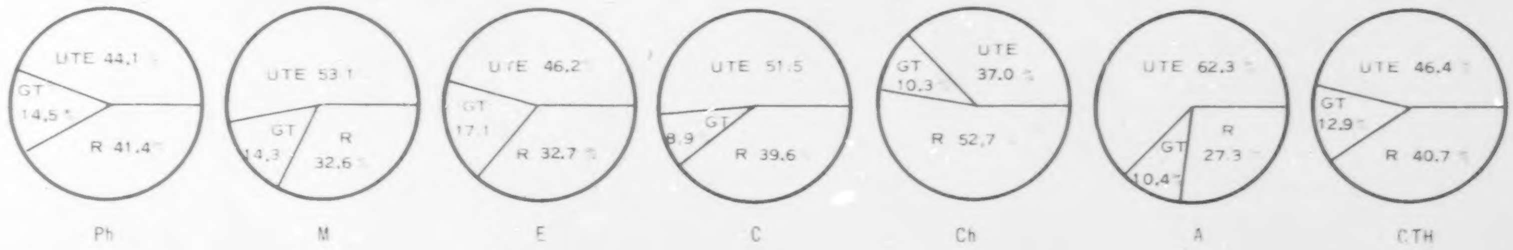
Figure 3

FINANCING STRUCTURE OF DEPARTMENTS, 1970/71
GRADUATE TRAINING AND TECHNICAL RESEARCH



## Figure 4

## RELATIONSHIPS BETWEEN TOTAL COSTS OF THE MAIN PROGRAMMES 1970/71



### Table 4 (b)

### TOTAL COSTS OF THE MAIN PROGRAMMES 1970/71

ThSwCr

| Department/Programme | Ph | M | E | C | Ch | A | Total |
|---|---|---|---|---|---|---|---|
| Undergraduate Technical Education | 8,439 | 6,627 | 7,346 | 6,729 | 7,020 | 2,937 | 39,098 |
| Graduate Training | 2,777 | 1,785 | 2,712 | 1,155 | 1,963 | 491 | 10,883 |
| Research | 7,917 | 4,075 | 5,835 | 5,174 | 10,010 | 1,287 | 34,298 |
| Total | 19,133 | 12,487 | 15,893 | 13,058 | 18,993 | 4,715 | 84,279 |

Table 4 (c)

MAN-DAY LOAD OF SCIENTISTS OF THE MAIN PROGRAMMES 1970/71

| Programme/ Section | Professor | | Associate Professor | | Assistant Professor | | Research assistant | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Man-days | % | Man-days | % | Man-days | % | Man-days | % | Man-days | % |
| 1. Undergraduate education | 6,280 | 42.7 | 1,561 | 40.0 | 571 | 22.0 | 756 | 18.9 | 9,168 | 36.4 |
| Ph. math. | 269 | 1.8 | 98 | 2.5 | 40 | 1.6 | 80 | 2.0 | 487 | 1.9 |
| Ph. phys. | 727 | 5.0 | 395 | 10.1 | 194 | 7.5 | 337 | 8.4 | 1,653 | 6.6 |
| M | 1,710 | 11.6 | 228 | 5.8 | 37 | 1.4 | 38 | 0.9 | 2,013 | 8.0 |
| E | 1,147 | 7.8 | 223 | 5.7 | 229 | 8.8 | 98 | 2.5 | 1,697 | 6.7 |
| C | 1,315 | 9.0 | 244 | 6.3 | | | 121 | 3.0 | 1,680 | 6.7 |
| Ch | 738 | 5.0 | 219 | 5.6 | 71 | 2.7 | 82 | 2.1 | 1,110 | 4.4 |
| A | 374 | 2.5 | 154 | 4.0 | | | | | 528 | 2.1 |
| 2. Graduate training | 3,578 | 24.4 | 1,007 | 25.8 | 551 | 21.2 | 1,065 | 26.6 | 6,201 | 24.6 |
| Ph. math. | 667 | 4.5 | 402 | 10.3 | 56 | 2.1 | 56 | 1.4 | 1,181 | 4.7 |
| Ph. phys. | 300 | 2.1 | 163 | 4.2 | 114 | 4.4 | | | 557 | 2.3 |
| M | 481 | 3.3 | 109 | 2.8 | 15 | 0.6 | 80 | 2.0 | 685 | 2.7 |
| E | 808 | 5.5 | 95 | 2.4 | 194 | 7.5 | 502 | 12.5 | 1,599 | 6.3 |
| C | 497 | 3.4 | 63 | 1.6 | | | 65 | 1.6 | 625 | 2.5 |
| Ch | 721 | 4.9 | 90 | 2.3 | 172 | 6.6 | 362 | 9.1 | 1,345 | 5.3 |
| A | 104 | 0.7 | 85 | 2.2 | | | | | 189 | 0.8 |
| 3. Research | 4,842 | 32.9 | 1,332 | 34.2 | 1,478 | 56.8 | 2,179 | 54.5 | 9,831 | 39.0 |
| Ph. math. | 264 | 1.8 | 100 | 2.6 | 304 | 11.7 | 264 | 6.6 | 932 | 3.7 |
| Ph. phys. | 773 | 5.3 | 442 | 11.3 | 292 | 11.2 | 463 | 11.6 | 1,970 | 7.8 |
| M | 809 | 5.5 | 63 | 1.6 | 148 | 5.7 | 282 | 7.1 | 1,302 | 5.2 |
| E | 645 | 4.4 | 82 | 2.1 | 177 | 6.8 | | | 904 | 3.6 |
| C | 538 | 4.0 | 93 | 2.4 | | | 214 | 5.3 | 895 | 3.5 |
| Ch | 1,241 | 8.4 | 191 | 4.9 | 557 | 21.4 | 956 | 23.9 | 2,945 | 11.7 |
| A | 522 | 3.5 | 361 | 9.3 | | | | | 883 | 3.5 |
| 4. Total | 14,700 | 100.0 | 3,900 | 100.0 | 2,600 | 100.0 | 4,000 | 100.0 | 25,200 | 100.0 |
| Ph. math. | 1,200 | 8.2 | 600 | 15.4 | 400 | 15.4 | 400 | 10.0 | 2,600 | 10.3 |
| Ph. phys. | 1,800 | 12.2 | 1,000 | 25.6 | 600 | 23.1 | 800 | 20.0 | 4,200 | 16.7 |
| M | 3,000 | 20.4 | 400 | 10.3 | 200 | 7.7 | 400 | 10.0 | 4,000 | 15.9 |
| E | 2,600 | 17.7 | 400 | 10.3 | 600 | 23.1 | 600 | 15.0 | 4,200 | 16.7 |
| C | 2,400 | 16.3 | 400 | 10.3 | | | 400 | 10.0 | 3,200 | 12.7 |
| Ch | 2,700 | 18.4 | 500 | 12.7 | 800 | 30.7 | 1,400 | 35.0 | 5,400 | 21.4 |
| A | 1,000 | 6.8 | 600 | 15.4 | | | | | 1,600 | 6.3 |

Table 4 (d)

## MAN-DAY LOAD OF THE MAIN PROGRAMMES 1970/71

(Summary)

| Section | Undergraduate education | | Research education | | Research | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Man-days | % | Man-days | % | Man-days | % | Man-days | % |
| Ph. math. | 487 | 18.7 | 1,181 | 45.4 | 932 | 35.9 | 2,600 | 100.0 |
| Ph. phys. | 1,653 | 39.4 | 577 | 13.7 | 1,970 | 46.9 | 4,200 | 100.0 |
| M | 2,013 | 50.3 | 685 | 17.1 | 1,302 | 32.6 | 400 | 100.0 |
| E | 1,697 | 40.4 | 1,599 | 38.1 | 904 | 21.5 | 4,200 | 100.0 |
| C | 1,680 | 52.5 | 625 | 19.5 | 895 | 28.0 | 3,200 | 100.0 |
| Ch | 1,110 | 20.6 | 1,345 | 24.9 | 2,945 | 54.5 | 5,400 | 100.0 |
| A | 528 | 33.0 | 189 | 11.8 | 883 | 55.2 | 1,600 | 100.0 |
| Total | 9,168 | 36.4 | 6,201 | 24.6 | 9,831 | 39.0 | 25,200 | 100.0 |

Appendix II A

## LIST OF ACTIVITIES

| Code | Notation | Definition |
|---|---|---|
| Undergraduate Technical Education (UTE) | | |
| 11 | Teaching | Lectures, teaching in class. Laboratory experiments. |
| 12 | Preparation of teaching | To allot and produce material used in the teaching work. e.g. to write a compendium, laboratory instruction or to develop a new laboratory experiment. |
| 13 | Educational planning and administration | To make up preliminary and final course programmes. To make up teaching and examination schedules. Meeting concerning undergraduate education. |
| 14 | Examination, UTE | To construct tests. Supervision in connection with examination. To mark papers. |
| 15 | Supervision, UTE | To assist students working on a thesis. To assist students regarding courses, overall planning of the education, etc. |
| Graduate Training (GT) | | |
| 21 | Graduate courses | To teach graduate courses. To conduct seminars. |
| 22 | Student activities, courses | To follow graduate courses, seminars, etc. |
| 23 | Preparation of courses | The teachers' preparations of graduate courses. |

| Code | Notation | Definition |
|---|---|---|
| 24 | Supervision, GT | To supervise graduate students concerning matters directly associated to graduate training, e.g. elementary research methods, the selection of topics for thesis work (cf. activity 34). |
| 25 | Student activities, supervision | To receive supervision described in 24. |
| 26 | Examination | Teachers' activities in connection with examination and graduation. |
| 27 | Student activities, studies | To study literature required for courses and seminars. |
| | | Research |
| 311 | Experimental research | Experimental work in laboratory or elsewhere characterized by some kind of measurement. |
| 312 | Theoretical research | To construct theories and hypotheses.<br>To work out models and to make mathematical calculations. |
| 32 | Preparation of experiments | Planning of research described in 311 and 312. To collect and construct equipment. To learn how to handle equipment. Testing. |
| 33 | Studies | To study literature in connection with research projects. Survey of abstracts and reports. |
| 34 | Project supervision | Discussion between project leader and other scientists on the project concerning technical and scientific problems. |
| 35 | Substantiation | To write reports, theses, articles, etc. |
| 36 | Research planning and administration | To apply for research grants. To make up the research programme of the division. Correspondence and documentation in connection with the planning. |
| 37 | Contacts | Conferences, symposia. Discussions and meetings with scientists from other divisions or institutes. |

| Code | Notation | Definition |
|---|---|---|
| 38 | External activities | Activities intended for customers other than the university, e.g. meetings with the research councils, external lectures, commissions as opponent. |
| 39 | Other research activities | Thinking, planning, reporting, etc., belonging to the division research programme but which cannot be referred to any of the activities 311-38. |

Administration

| | | |
|---|---|---|
| 41 | Budgeting and accounting | To work out division budgets, to allot resources to the different accounts, to plan investments, to make appointments. |
| 42 | Library service | To keep the library in order, to buy new books, to make subcriptions, etc. |
| 43 | Other joint administration | Questions of personnel, mail, rooms, meetings. |
| 44 | Sickness, leave, vacation | |

Appendix II B

## THE PILOT STUDY : DIVISION OF APPLIED ELECTRONICS (DAE)

### 1. GENERAL DESCRIPTION OF ACTIVITIES AND ORGANIZATION

DAE belongs to the Department of Electrical Engineering. It has two professors and twelve assistants and the total costs amount to around two million SwCr. Salaries amount to 75 per cent of total costs and it is the biggest division of the department.

DAE is divided into two sections :

I. Medical Electronics
II. Applied Electronics
each having one professorship.

The section for applied electronics is responsible for the main part of the undergraduate technical education (six out of seven courses). The courses of applied electronics are devoted to the design, function and properties of passive and active electronic components. The courses are fairly advanced and require knowledge of elementary courses of electricity and physical electronics. Consequently they are intended for students in the third and fourth years of study.

The section of medical electronics offers one course named Medical Electronics which is optional for students in the fourth year. This course contains both a medical and a technical part and comprises a total of 308 hours of work. Since the course is one of the first in Sweden in this field of study it has gained great popularity among the students.

The partition of the division into sections is not relevant with regard to the research programme, since the whole division for many years has been totally concentrated on medical electronics. The research programme is characterized by an active co-operation with different clinical departments and laboratories at the hospitals in Gothenburg and with Kaiser"s Laboratory in Copenhagen. The scientists and graduate students get in touch daily with practical problems at the hospital, and the research programme is mainly concerned with developing tools that can be applied to the ordinary medical work. Examples of projects of this kind are "Control of aids for the handicapped" and "Telephone-line telemetry of multichannel EEG", projects that recently have proved very successful.

The division is associated to the Centre of Medical Engineering in Gothenburg and is responsible for the main part of research going on within this Centre. The division and the centre are currently involved in international co-operation. In 1972 the Third International Conference on Medical Physics and Medical Engineering will be held in Gothenburg.

The research programme Medical Electronics defined in this report is a very differentiated programme aiming at the development of instruments and equipment for the purpose of investigating different parts of the body, such as the heart, the eye and the lungs. The following projects illustrate the nature of the research activities :

- Automatic computation of cardiac output by the thermodilution method;
- Development of X-ray television;
- Equipment for measuring ratio air-to-fluid in lungs;
- Localization of intraocular foreign bodies through X-ray technique;
- Television kymography.

Aids for the Handicapped aims at developing equipment for controlling different parts of the body, especially the arms and the hands. EMG-signals (electromyogram). The programme concerns the treatment of these signals and how to improve their quality. One project works with electrodes which absorb the signals in the skin. It has been possible to work out methods for identifying signal patterns and in this way control motorized activities of the aids. The main problem is one of optimizing the signal interactions between the patient and the mechanical aids for controlling activities.

The Work Physiology programme makes use of research results from the former programme. Generally the programme studies the interactions between man and his surroundings during physical work processes. The activities of the muscles during complex movements are subject to thorough investigation. Another important objective of the programme is to study the effects of noise.

EEG-analysis (encephalogram) is a fundamental research programme comprising different aspects of the encephalogram-signals. As for the EMG-signals it is important to recognize patterns of the EEG-signals through statistical analysis. The development of methods for the transmission of EEG-signals over the telephone-line is an important project which was recently successful. An important objective is to establish an EEG-central where EEG-signals can be received, analyzed and interpreted automatically. This project co-operates with the central health authority for the area around Gothenburg.

The size of DAE is a good reason for having a fairly well-developed administrative organization. The following administrative functions exist :

1. Undergraduate Student Service
2. Cost and Cash Accounting
3. Supply and Laboratory Service
4. Division Library.

Undergraduate student service comprises handling of examination books, lists of passed exams, marked papers, etc. For every student taking courses at the division there is a card where achievements are noted. One of the secretaries devotes about 50 per cent of her work time to this function.

Cost and Cash Accounting is important since the division receives grants from many different authorities. Expenses for materials and equipment cover about 25 per cent of the budget. The actual bookkeeping is handled by one secretary in co-operation with a research engineer in charge of the function.

Supply and Laboratory Service is responsible for the purchase and storing of electronic equipment, components and other materials necessary for the activities. A research engineer is in charge of the operations and he is assisted by a laboratory engineer. This function also assists the undergraduate students doing their thesis work at the division.

The Division Library is an important unit of the division and library expenses amount to as much as 38,000 SwCr. Two administrative assistants handle the management of the library.

## 2. VOLUME OF THE PROGRAMMES

### Undergraduate Technical Education

Table 1 (a)

COURSES 1970/71

| Courses | Number of students | Education | | | | | Examination | | Costs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture periods | Lesson periods | Lab. periods | Super- vision hours | Total hours | Number of passed exams | Exam % | Total (ThSwCr) | Costs/ hour (SwCr) | Costs/ student (SwCr) | Costs/ passed exam (SwCr) |
| Electrical Circuit Engineering | 180 | 56 | 336 | 1215 | 180 | 1787 | 182 | 101.1 | 199.3 | 112 | 1107 | 1095 |
| Electronic Control Engineering | 77 | 56 | 42 | 252 | 76 | 426 | 59 | 76.6 | 80.9 | 190 | 1051 | 1371 |
| Sensitive Amplifiers | 37 | 28 | 14 | 252 | 70 | 364 | 30 | 81.1 | 47.6 | 131 | 1286 | 1587 |
| Filter Engineering | 88 | 28 | 14 | 252 | 70 | 364 | 29 | 33.0 | 46.8 | 12[illegible] | 532 | 1614 |
| Medical Electronics | 34 | 112 | 168 | 210 | 60 | 550 | 31 | 91.2 | 77.7 | 141 | 2285 | 2506 |
| Total | 416 | 280 | 574 | 2181 | 456 | 3491 | 331 | 76.6 | 452.3 | 130 | 1087 | 1366 |

Table 1 (b)

THESIS WORKS 1970/71

| | |
|---|---|
| Number of thesis works | 19 |
| Number of thesis workers | 32 |
| Total costs | 66 200 Sw Cr |
| Costs/thesis work | 3 484 Sw Cr |
| Costs/thesis worker | 2 069 Sw Cr |

### Graduate Training

Table 2 (a)

COURSES 1970/71

| Courses | Number of students | Education | | | Examination | | Costs | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture periods | Super- vision hours | Total hours | Number of passed exams | Exam % | Total (ThSwCr) | Costs/ hour (SwCr) | Costs/ student (SwCr) | Costs/ passed exam (SwCr) |
| Medical Electronics | 20 | 45 | 250 | 295 | 20 | 100 | 16.4 | 56 | 820 | 820 |

Table 2 (b)

GRADUATE STUDENTS 1970/71

| Terms of situation | Number of graduate students | Number of passed exams |
|---|---|---|
| Candidate for the licentiate | 4 | 2 |
| Candidate for the doctor's degree | 2 | 1 |
| Candidate for the doctorate | 7 | |
| Total | 13 | 3 |
| Assistant lecturer | 8 | 2 |
| Research assistant | | |
| External research assistant | 3 | 1 |
| Holder of scholarship | 1 | |
| Other | 1 | |
| Total | 13 | 3 |

## Research

Table 3

RESEARCH PROGRAMMES 1970/71

Figures according to Survey of Time Utilization

| Research Programmes | Notation | Number of projects | Costs (ThSwCr) | | | | Research Personnel | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Materials and equipment | | Total | | Scientists | | Graduate students | | Total | |
| | | | Programme | per project | Programme | per project | Number | Man-days | Number | Man-days | Number | Man-days |
| Medical Electronics | ME | 15 | 62.6 | 4.2 | 615.9 | 41.1 | 2 | 222 | 5 | 337 | 7 | 559 |
| Work Physiology | AF | 2 | 123.9 | 62.0 | 219.5 | 109.8 | $\frac{1}{3}$ | 19 | 2 | 170 | $2\frac{1}{3}$ | 189 |
| Aids for the Handicapped | HF | 6.5 | 18.1 | 2.8 | 139.0 | 21.4 | $\frac{1}{3}$ | 19 | 2 | 328 | $2\frac{1}{3}$ | 347 |
| EEG-Analysis | EEG | 6.5 | 50.1 | 7.7 | 206.7 | 31.8 | $\frac{1}{3}$ | 19 | 3 | 255 | $3\frac{1}{3}$ | 274 |
| Total | | 30 | 254.7 | 8.5 | 1181.1 | 39.4 | 3 | 279 | 12 | 1090 | 15 | 1369 |

## 3. RESOURCES

### Personnel Statement

Table 4 (a)

TOTAL SALARY COSTS 1970/71 ALLOTTED TO
PERSONNEL CATEGORIES AND PROGRAMMES
ACCORDING TO TIME UTILIZATION

| Personnel categories | Number | Undergraduate education | Graduate training | Research | Administration | Total |
|---|---|---|---|---|---|---|
| Professor | 2 | 18.7 | 37.5 | 93.6 | 37.4 | 187.2 |
| University lecturer | 1 | 63.2 | 0.7 | 5.7 | 2.2 | 71.8 |
| External research assistant | 4 | 25.3 | 15.6 | 197.3 | 2.4 | 240.6 |
| Assistant lecturer | 7 | 162.5 | 20.7 | 146.9 | 15.6 | 345.7 |
| Administrative personnel | 3 | 15.8 | | 10.7 | 42.8 | 69.3 |
| Technical personnel | 10 | 33.6 | 4.6 | 280.3 | 71.5 | 390.0 |
| Total | 27 | 360.3 | 114.4 | 695.4 | 134.5 | 1304.6 |

Table 4 (b)

MAN-DAYS ALLOTTED TO PERSONNEL CATEGORIES
AND PROGRAMMES. DATA FROM
PRELIMINARY BUDGET 1970/71

(200 man-days/person and year)

| Personnel categories | Number | Undergraduate education | Graduate training | Research | | Total |
|---|---|---|---|---|---|---|
| Professor | 2 | 128 | 156 | 116 | | 400 |
| University lecturer | 1 | 146 | 7 | 47 | | 200 |
| Assistant lecturer | 8 | 888 | 456 | 256 | | 1600 |
| Other assistant | 3 | 600 | | | | 600 |
| Special master | 1/3 | 32 | 28 | | | 60 |
| Assistant master | 1/3 | 60 | | | | 60 |
| Total | 14 2/3 | 1854 | 647 | 419 | | 2920 |

## Table 4 (c)

## SURVEY OF TIME UTILIZATION

### Division : Applied Electronics

A. Work Report. Week nr : 19 1971

| Personnel categories | Number | Time Utilization in percentage | | | |
|---|---|---|---|---|---|
| | | Undergraduate education | Graduate training | Research | Administration |
| Professor, associate professor | | | | | |
| University lecturer | 1 | 96 | | 4 | |
| Assistant prof, research assistant | | | | | |
| External research assistant | 3 | 11 | 1 | 82 | 6 |
| Research engineer | 2 | 26 | | 51 | 23 |
| Graduate stud. assistant | 7 | 41 | 4 | 53 | 2 |
| Grad. stud. scholarship | 1 | 25 | 2 | 73 | |
| Other assistants | | | | | |
| Grad. stud. other | | | | | |
| Techn. personnel | 9 | 1 | | 96 | 3 |
| Adm. personnel | 2 | 27 | | 17 | 56 |
| Other personnel | | | | | |

B. Time Utilization Survey 1970/71

| Personnel categories | Number | Time Utilization in percentage | | | |
|---|---|---|---|---|---|
| | | Undergraduate education | Graduate training | Research | Administration |
| Professor, associate professor | 1 | 10 | 20 | 50 | 20 |
| University lecturer | 1 | 88 | 1 | 8 | 3 |
| Assistant prof. research assistant | | | | | |
| External research assistant | 3 | 10.5 | 6.5 | 80 | 1 |
| Research engineer | 2 | 21.5 | 4.5 | 24 | 50 |
| Graduate stud. assistant | 7 | 47 | 6 | 42.5 | 4.5 |
| Grad. stud. scholarship | 1 | 11 | 28 | 61 | |
| Other assistants | | | | | |
| Grad. stud. other | | | | | |
| Techn . personnel | 9 | 4 | | 89 | 7 |
| Adm. personnel | 1 | 28 | | 19 | 53 |
| Other personnel | | | | | |

Table 4 (d)

TIME UTILIZATION WITH REGARD TO ACTIVITIES

Division : Applied Electronics

☒ Work Report week nr :19

☐ Time Utilization Survey

| Personnel categories | Number | Activities |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | 11 | 12 | 13 | 14 | 15 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 311 | 312 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 41 | 42 | 43 | 44 |
| Professor, associate professor |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Lecturer | 1 | 26 | 41 | 7 | 8 | 14 |  |  |  |  |  |  |  |  |  | 4 |  |  |  |  |  |  |  |  |  |  |  |
| Assistant professor, research assistant |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| External research assistant | 3 |  | 1 |  | 3 | 7 |  | 1 |  |  |  |  |  | 3 | 8 | 27 | 9 | 4 | 16 | 9 | 6 | 6 |  |  |  |  | 6 |
| Research engineer | 2 |  | 6 |  | 6 | 14 |  |  |  |  |  |  |  | 8 |  | 17 | 2 |  | 14 |  | 10 |  |  | 19 | 2 | 2 |  |
| Graduate student assistant | 7 | 18 | 18 |  | 2 | 3 |  | 1 |  |  | 1 |  | 2 | 13 | 2 | 16 | 1 | 1 | 15 | 1 | 4 |  |  |  |  | 2 |  |
| Graduate student scholarship | 1 | 19 | 6 |  |  |  |  | 2 |  |  |  |  |  |  | 26 | 19 | 1 | 14 |  |  |  |  | 13 |  |  |  |  |
| Other assistant |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Graduate student, other |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Technical personnel | 9 | 1 |  |  |  |  |  |  |  |  |  |  |  | 20 |  | 47 |  | 1 | 19 |  | 3 |  | 6 | 3 |  |  |  |
| Administrative personnel | 2 | 3 | 19 | 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 6 | 6 | 5 |  |  | 21 |  | 35 |  |
| Other personnel |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Table 4 (e)

TIME UTILIZATION WITH REGARD TO ACTIVITIES

Division : Applied Electronics

☐ Work Report

☒ Time Utilization Survey 1970/71

| Personnel categories | Number | Activities 11 | 12 | 13 | 14 | 15 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 311 | 312 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 41 | 42 | 43 | 44 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Professor, associate professor | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lecturer | 1 | 15 | 40 | 10 | 10 | 13 | | 1 | | | | | | 5 | | 2 | 1 | | | | | | | 1 | | 2 | |
| Assistant professor, research assistant | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| External research assistant | 3 | 2 | 2 | | 0.5 | 6 | | 3 | | | 0.5 | | 3 | 12.5 | 4 | 6 | 10 | 3.5 | 24 | 10.5 | 4 | 7 | 0.5 | | | 1 | |
| Research engineer | 2 | | 3 | 5 | 0.5 | 13 | | | 0.5 | | 1 | | 3 | 5 | | 1.5 | 1.5 | | 0.5 | 2 | 11 | | 2.5 | 24 | 5 | 21 | |
| Graduate student assistant | 7 | 13 | 19 | 3 | 7 | 5 | | 4 | | | 2 | | | 21 | 3.5 | 7 | 2 | 2 | 3 | 0.5 | 1 | 1 | 1.5 | 0.5 | | 4 | |
| Graduate student scholarship | 1 | 10 | 1 | | | | | 10 | | | 1 | | 17 | 7 | 10 | 13 | 7 | 13 | 1 | | 3 | | 7 | | | | |
| Other assistant | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Graduate student other | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Technical personnel | 9 | | 2.5 | | | 1.5 | | | | | | | | 43.5 | 2 | 26.5 | 6 | 1.5 | 3 | 0.5 | 1 | 0.5 | 4.5 | 1 | | 6 | |
| Administrative personnel | | | | 28 | | | | | | | | | | | | | | | 19 | | | | | | 53 | | |
| Other personnel | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Materials and Accessories

Material and accessory costs are calculated from lists of costs produced by the computer system.

Table 5

MATERIAL AND ACCESSORY COSTS 1970/71 ALLOTTED TO PROGRAMMES

Th Sw Cr

| Materials and accessories | Under-graduate education | Graduate training | Research | Assistant accounts of costs | Total |
|---|---|---|---|---|---|
| Total costs | 13.6 | 6.0 | 60.1 | 148.2 | 227.9 |

Equipment

In 1970, when the division moved into a new part of the Electrical Engineering building, it received 210 ThSwCr for equipment from the Equipment Board for the Swedish Universities. In addition the division also makes use of the ordinary grant from the Office of the Chancellor of the Swedish Universities for purchasing equipment.

Table 6

EQUIPMENT COSTS 1970/71 ALLOTTED TO PROGRAMMES

Th Sw Cr

| Equipment | Under-graduate education | Graduate Training | Research | Assistant accounts of costs | Total |
|---|---|---|---|---|---|
| Total costs | 6.6 | 16.9 | 194.6 | 7.1 | 225.2 |

| | | | |
|---|---|---|---|
| Grant from Equipment Board 1971 | : | 210 | ThSwCr |
| Re-investment price, calculated on basis of 5 per cent price increase | : | 220.5 | ThSwCR |
| Depreciation per year, when depreciation time of 10 years | : | 22.1 | ThSwCr |
| Annuity, calculated on basis of 8 per cent | : | 8.8 | ThSwCr |
| Total costs per year | : | 30.9 | ThSwCr |

### Rooms

The space costs are based on a medial price of 180 SwCr/m2.

Table 7(a)

ROOM STATEMENT 1970/71

| Type of room | Number of rooms | Total area (m2) | Average area/room (m2) | Total costs (Th Sw Cr) | Average costs/room (Th Sw Cr) |
|---|---|---|---|---|---|
| Office room | 24 | 535.7 | 22.3 | 96.4 | 4.0 |
| Seminary room | 1 | 58.6 | 58.6 | 10.6 | 10.6 |
| Laboratory | 36 | 1177.6 | 32.7 | 212.0 | 5.9 |
| Library | 3 | 87.4 | 29.1 | 15.7 | 5.2 |
| Supply | 3 | 105.6 | 35.2 | 19.0 | 6.3 |
| Workshop | 2 | 38.5 | 19.3 | 6.9 | 3.5 |
| Total | 69 | 2003.4 | 29.0 | 360.6 | 5.2 |

Table 7(b)

SPACE COSTS OF THE PROGRAMMES 1970/71

Th Sw Cr

| Rooms | Under-graduate education | Graduate training | Research | | Total |
|---|---|---|---|---|---|
| Total costs | 47.3 | 20.8 | 292.5 | | 360.6 |

## 4. DIVISION BUDGET

### Assistant Accounts of Costs

- Administration
- Library
- Reproduction
- Instrument Workshop
- Laboratory
- Supply

### Keys for the allotment of Costs

The costs of administration and library activities are allotted to carriers of costs in accordance with total direct costs (division budget : T1 + T2). Since the instrument workshop principally offers service to the research programmes, the costs of this function has only been allotted to these programmes. The allotment is expressed as a percentage of the basis of total direct costs. The costs of the remaining assistant accounts are allotted in accordance with work reports from the personnel.

Table 8

DIVISION BUDGET PAGE 1

Division : Applied Electronics
Division Code : 738
Fiscal Year : 1970/71

☐ Budget
☐ Adjusted budget
☒ Audited budget

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Carriers of costs |  |  |  |  |  |  |  |  |  | Assistant accounts of costs |  |  |  |  |  |  |
|  |  |  |  |  |  | Research projects |  |  |  |  |  |  |  |  |  |  |  |
| Costs/Revenues | Courses CTH | Courses GU | Under-grad thesis works | Graduate courses | Remaining graduate training | ME | HF | AF | EEG | Commission | Administration | Library | Reproduction | Instr. workshop | Laboratory | Workshop | Total |
| Prof, associate prof | 14.0 |  | 4.7 | 5.2 | 32.3 | 46.8 | 18.7 | 9.4 | 18.7 |  | 37.4 |  |  |  |  |  | 187.2 |
| Asst.prof, research asst. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| External research asst. | 10.9 |  | 14.4 | 7.2 | 8.4 | 111.9 | 85.4 |  |  |  | 2.4 |  |  |  |  |  | 240.6 |
| University lecturer | 53.8 |  | 9.4 | 0.7 |  | 5.7 |  |  |  |  | 2.2 |  |  |  |  |  | 71.8 |
| Asst. lecturer | 145.3 |  | 17.2 | 13.8 | 6.9 | 50.7 |  | 23.5 | 72.7 |  | 15.6 |  |  |  |  |  | 345.7 |
| Adm. personnel | 19.4 |  |  |  |  | 6.6 | 2.2 | 2.2 | 2.2 |  | 23.7 | 13.0 |  |  |  |  | 69.3 |
| Tech. personnel |  |  |  |  |  |  |  |  |  |  | 58.0 |  | 29.6 | 37.0 | 220.6 | 44.8 | 390.0 |
| Prof. hours | 1.9 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.9 |
| Lecturer hours |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Asst. hours | 177.2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 177.2 |
| Remaining remunerations | 0.4 |  |  |  |  |  |  |  |  |  | 6.5 |  |  |  | 6.5 |  | 13.4 |
| T1 : Salaries and Remunerations | 453.6 |  | 56.2 | 31.8 | 78.0 | 201.7 | 96.5 | 34.6 | 83.8 | 1.0 | 108.4 | 13.0 | 29.6 | 37.0 | 227.1 | 44.8 | 1497.1 |
| Materials, etc... | 11.0 |  | 2.6 | 2.4 | 3.6 | 25.8 | 12.7 | 1.8 | 18.8 |  | 23.2 | 24.6 | 27.5 | 0.8 | 67.1 | 5.0 | 227.9 |
| Equipment | 6.5 |  | 0.1 |  | 16.9 | 35.8 | 5.4 | 122.1 | 31.3 |  |  |  | 0.5 |  | 5.0 | 1.6 | 225.2 |
| Scholarships |  |  |  |  | 14.2 |  |  |  |  |  |  |  |  |  |  |  | 14.2 |
| Computer time |  |  |  |  |  |  |  | 11.0 | 11.0 |  |  |  |  |  |  |  | 22.0 |
| Revenues |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | -3.0 | - 3.0 |
| T2 : Remaining Costs | 17.5 |  | 2.7 | 2.4 | 34.7 | 62.6 | 18.1 | 134.9 | 61.1 |  | 23.2 | 24.6 | 28.0 | 0.8 | 72.1 | 3.6 | 486.3 |
| T1 + T2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Total Direct Costs | 471.1 |  | 58.9 | 34.2 | 112.7 | 264.3 | 114.6 | 169.5 | 144.9 | 1.0 | 131.6 | 37.6 | 57.6 | 37.8 | 299.2 | 48.4 | 1983.4 |

Table 8 (cont.)

DIVISION BUDGET PAGE 2

Division : Applied Electronics
Division Code : 738
Fiscal Year : 1970/71

☐ Budget
☐ Adjusted budget
☒ Audited budget

ThSwCr

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8 | 9 | 10 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Carriers of costs | | | | | | | | | | |
| Costs/Revenues | Courses CTH | Courses GU | Undergrad thesis work | Graduate courses | Remaining graduate training | Research projects | | | | | Total |
| | | | | | | ME | HF | AF | EEG | Commission | |
| Administration (col 12) | 45.1 | | 5.7 | 3.3 | 10.8 | 25.4 | 10.9 | 16.3 | 14.0 | 0.1 | 131.6 |
| Library (col 13) | 12.9 | | 1.6 | 0.9 | 3.1 | 7.3 | 3.1 | 4.7 | 4.0 | | 37.6 |
| Reproduction (col 14) | 5.9 | | | | | 44.2 | 4.2 | | 3.3 | | 57.6 |
| Instr. rep. (col 15) | | | | | | 14.4 | 6.2 | 9.3 | 7.9 | | 37.8 |
| Laboratory (col 16) | 6.0 | | | | | 240.9 | | 19.7 | 32.6 | | 299.2 |
| Workshop (col 17) | 24.2 | | | | 4.8 | 19.4 | | | | | 48.4 |
| T3 : Allotted Joint Costs | 94.1 | | 7.3 | 4.2 | 18.7 | 351.6 | 24.4 | 50.0 | 61.8 | 0.1 | 312.2 |
| T1 + T2 + T3 : Total Costs | 565.2 | | 66.2 | 38.4 | 131.4 | 615.9 | 139.0 | 219.5 | 206.7 | 1.1 | 1983.4 |
| BTD | | | | | | 179.1 | 694.6 | | | | 873.7 |
| Volvo | | | | | | | | 360.0 | | | 360.0 |
| Telecommunication Research | | | | | | 6.2 | | | | | 6.2 |
| Telecommunication Research Reserv. | | | | | | 29.5 | | | | | 29.5 |
| Graduate students | | | | | 1.7 | | | | | | 1.7 |
| Doctorate scholarship | | | | | 14.2 | | | | | | 14.2 |
| Computer time | | | | | | | | 11.0 | 11.0 | | 22.0 |
| Revenues | 4.5 | | | | | | | | | 4.2 | 8.7 |
| T4 : Total Revenues | 4.5 | | | | 15.9 | 214.8 | 694.6 | 371.0 | 11.0 | 4.2 | 1316.0 |
| T1 + T2 + T3 - T4<br>Programme grant | 560.7 | | 66.2 | 38.4 | 115.5 | 401.1 | -555.6 | -151.5 | 195.7 | -3.1 | 667.4 |

Table 8 (cont.)

DIVISION BUDGET PAGE 3

SUMMARY

Division : Applied Electronics
Division Code : 738
Fiscal Year : 1970/71

☐ Budget
☐ Adjusted budget
☒ Audited budget

ThSwkr

| Grants | P1<br>Undergrad. education CTH | P2<br>Undergrad. education GU | P3<br>Graduate training | P4<br>Research | Total |
|---|---|---|---|---|---|
| Graduate students grants | | | | | |
| Grant to asst. professors and research assistants | | | | | |
| Remaining programme grant | 626.9 | | 153.9 | -113.4 | 667.4 |
| A Programme grant | 626.9 | | 153.9 | -113.4 | 667.4 |
| External resources | | | - | 1269.4 | 1269.4 |
| Graduate scholarships | | | 14.2 | | 14.2 |
| Special grants for graduate training | | | | | |
| Computer time | | | | 22.0 | 22.0 |
| Remaining Revenues | 4.5 | | 1.7 | 4.2 | 10.4 |
| B Total Revenues | 4.5 | | 15.9 | 1295.6 | 1316.0 |
| A + B Total Costs | 631.4 | | 169.8 | 1182.2 | 1983.4 |

Appendix II C

## PILOT STUDY ANALYSIS

Table 1

TEACHING LOAD, HIGH OFFICES

| | Unit | DAE | DSM | DTP | CTH | Comments |
|---|---|---|---|---|---|---|
| Professor, associate prof. | Holders of office | 2 | 1 | 6 | 84 | Permanent Staff |
| Assistant professor | | | | 2 | 8 | |
| Research assistant | | | | 1 | 13 | |
| University lecturer | | 1 | 1 | 6.5 | 61 | |
| Time for UTE (calculated)(1) | Hours/year | 1980 | 1584 | 11142 | 115254 | Only permanent staff |
| Time for UTE (permanent staff) | Hours/year | 2192 | 1920 | 14632 | 149992 | (8 hours/day) |
| Time for UTE (extra staff, masters) | Hours/year | 736 | | | 49968 | (8 hours/day) |
| Teaching load (lectures) | Periods/year | 280 | 84 | 826 | 18270 | |
| Relative teaching load (calculated) | $\frac{\text{Lectures}}{\text{Hours for UTE}}$ | 0.14 | 0.05 | 0.07 | 0.16 | Lectures divided by calc.time for UTE |
| Relative teaching load (actual) | $\frac{\text{Lectures}}{\text{Hours for UTE}}$ | 0.10 | 0.04 | 0.07 | 0.09 | Lectures divided by total time for UTE |
| Time for UTE (calculated) | % of total time | 41.7 | 62.5 | 45.4 | 42.4 | cf Table 4 : 15 |
| Time for UTE (actual) | % for total time | 36.0 | 26.5 | 31.0 | | |
| Total time for UTE (perm+extra staff) | Hours/year | 2928 | 1920 | 11142 | 199960 | According to man-day load |

1) Professor/Associate Professor = 3 X 132 = 396 hours/year
Assistant Professor = 3 X 75 = 225 hours/year
Research Assistant = 198 hours/year
University Lecturer = 3 X 396 = 1188 hours/year

Table 2

TEACHING LOAD, ASSISTANT LECTURERS AND EXTRA ASSISTANTS

| | Unit | DAE | DSM | DTP | CTH | Comments |
|---|---|---|---|---|---|---|
| Assistant lecturer<br>Grad.stud.(scholarship) | Holders of office | 8<br>1 | 3 | 14<br>3 | 243<br>45 | |
| Time for UTE (calculated) | Hours/year | 8000 | 3000 | 14000 | 243000 | Only permanent staff |
| Time for UTE (permanent staff) | Hours/year | 7104 | 3376 | 8680 | 224696 | (8 hours/day) |
| Time for UTE (extra staff) | Hours/year | 4800 | 2720 | 1920 | 154632 | |
| Total time for UTE (perm+extra staff) | Hours/year | 11904 | 6096 | 10600 | 379328 | According to man-day load |
| Teaching load (practice, lab, supervision) | Periods/year | 3211 | 798 | 2331 | | |
| Relative teaching load (calculated) | $\frac{\text{Periods}}{\text{Hours for UTE}}$ | 0.40 | 0.27 | 0.17 | | Periods divided by calc.time for UTE |
| Relative teaching load (actual) | $\frac{\text{Periods}}{\text{Hours for UTE}}$ | 0.27 | 0.13 | 0.22 | | Periods divided by total time for UTE |
| Time for UTE (assistant lecturers) | % of total time | 47.0 | 41.0 | 41.3 | | |
| Time for UTE (grad.students) | % of total time | 11.0 | | 14.6 | | |

Table 3

COSTS OF UNDERGRADUATE TECHNICAL EDUCATION

| | Unit | DAE | DSM | DTP | CTH |
|---|---|---|---|---|---|
| Total costs of courses | ThSwCr/year | 565.2 | 174.7 | 1425.9 | 23422.8 |
| Total teaching load | Periods/year | 3491 | 882 | 3157 | |
| Total number of passed exams | Passed exams/year | 331 | 180 | 582 | |
| Total costs per period | $\frac{\text{ThSwCr}}{\text{period}}$ | 0.16 | 0.20 | 0.45 | |
| Total costs per passed exam. | $\frac{\text{ThSwCr}}{\text{exam}}$ | 1.71 | 0.97 | 2.45 | |
| Total costs of examination works | ThSwCr/year | 66.2 | 71.3 | 20.2 | 3566.8 |
| Number of examination workers | Students/year | 32 | 32 | 4 | 735 |
| Total costs per examination worker. | $\frac{\text{ThSwCr}}{\text{student}}$ | 2.07 | 2.23 | 5.05 | 4.85 |

Table 4

GRADUATE TRAINING LOAD

| | Unit | DAE | DSM | DTP | CTH | Comments |
|---|---|---|---|---|---|---|
| Graduate students (assistant lecturers) | Students | 8 | 3 | 14 | 347 | |
| Graduate students (scholarship) | Students | 1 | | 3 | 66 | |
| Graduate students (others) | Students | 4 | 7 | 7 | 329 | |
| Total number of graduate students | Students | 13 | 10 | 24 | 742 | |
| Supervisors | Supervisor | 2 | 2 | 9 | 128 | University lectures not included |
| Graduate students per supervisor | Students/supervisor | 6.5 | 5.0 | 2.7 | 5.8 | |
| Supervisor time for GT (man-day load) | Man-days | 191 | 58 | 372 | 5598 | (prof, lect, masters) |
| Student time for GT (man-day load) | Man-days | 456 | 87 | 693 | 16822 | (assistants) |
| GT load (student time/superv. time | Man-days/Man-days | 2.39 | 1.50 | 1.86 | 3.0 | |
| Supervisor time for GT | Hours/year | 656 | 312 | 3585 | | 1600 hours/year |
| Student time for GT | Hours/year | 1120 | 1520[1] | 5508 | | 1600 hours/year |
| GT load student time/superv. time | Hours/Hours | 1.70 | 4.87 | 1.53 | | |

1) Other grad. students, total time = 800 hours/year.

Table 5

COSTS OF GRADUATE TRAINING

| | Unit | DAE | DSM | DTP | CTH | Comments |
|---|---|---|---|---|---|---|
| Total costs of graduate training | ThSwCr/year | 153.9 | 90.8 | 306.1 | 10983 | Col 5+6, Table 2a |
| Total number of grad. students | Students | 13 | 10 | 24 | 742 | |
| Total costs per grad. student | ThSwCr/student | 11.8 | 9.1 | 12.8 | 14.7 | |
| Total man-days for GT | Man-days/year | 647 | 145 | 1065 | 6464 | (supervisor+student) |
| Total costs per man-day | ThSwCr/man-day | 0.24 | 0.63 | 0.29 | 1.7 | |

Table 6

VOLUME OF THE RESEARCH PROGRAMME

| | Unit | DAE | DSM | DTP | CTH | Comments |
|---|---|---|---|---|---|---|
| Research projects | Projects | 30 | 10 | 35 | | |
| Research staff<br>Total scientists | Scientists | 15 | 11 | 40 | 870 | Supervisors+grad. students |
| Man-day load | Man-days/year | 1369 | 880 | 3328 | 9831 | Table 4(c) |
| Man-day load per project | Man-days / project year | 45.7 | 88.0 | 95.1 | | |
| Volume of staff per project | Scientists / project | 0.5 | 1.1 | 1.1 | | |
| Technical and adm. load | Man-days/year | 1678 | 712 | 530 | 6265 | (200 man-days/year) |
| Technical and adm. load | Man-days / proj. and year | 55.9 | 71.2 | 15.2 | | |
| Technical and adm. load | Man-days / Scientist man-days | 1.2 | 0.8 | 0.2 | 0.6 | |

Table 7

FINANCING STRUCTURE OF THE RESEARCH PROGRAMME

| | Unit | DAE | DSM | DTP | CTH | Comments |
|---|---|---|---|---|---|---|
| Total costs of the research programme | ThSwCr/year | 1182.2 | 582.3 | 1127.3 | 34298 | Table 3(a) |
| (RC o F) Revenues from research councils and foundations | ThSwCr | 909.4 | 415.0 | 441.0 | 12613 | Table 3(e) |
| | % of total costs | 76.8 | 71.3 | 39.1 | 36.8 | |
| Research from industry | ThSwCr | 364.2 | | | 1310 | |
| | % of total costs | 30.7 | | | 3.8 | |
| Total external revenues | ThSwCr | 12736 | 415.0 | 441.0 | 13923 | Only research councils foundations and industry |
| | % of total costs | 107.5 | 71.3 | 39.1 | 40.6 | |

REVENUES FROM RESEARCH COUNCILS AND FOUNDATIONS IN PERCENTAGE OF TOTAL COSTS

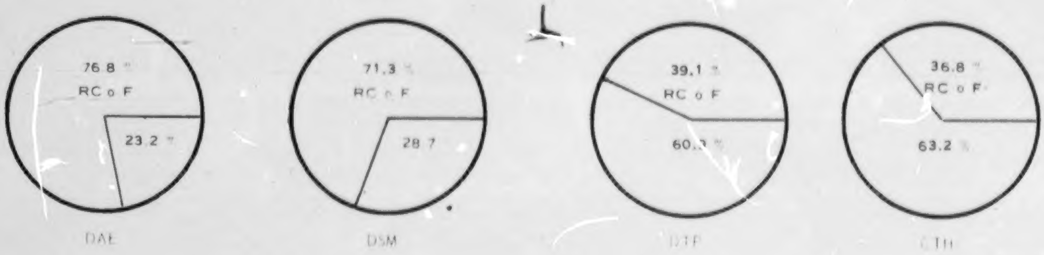


Table 8

STRUCTURE OF COSTS OF THE RESEARCH PROGRAMME

| | Unit | DAE | DSM | DTP | CTH | Comments |
|---|---|---|---|---|---|---|
| Total research costs | ThSwCr | 1182.2 | 582.3 | 1127.3 | 34298.0 | |
| Salaries (S) | ThSwCr | 695.4 | 425.3 | 857.7 | | |
| | % of total costs | 58.7 | 73.0 | 76.1 | | |
| Materials and equipment (M) | ThSwCr | 254.7 | 85.8 | 41.0 | | |
| | % of total costs | 21.4 | 14.8 | 3.6 | | (only direct costs) |
| Computer time (C) | ThSwCr | 22.0 | 5.0 | 95.0 | 1755.0 | |
| | % of total costs | 1.9 | 0.9 | 8.4 | 5.1 | |
| Space | ThSwCr | 292.5 | 62.2 | 68.2 | | (Space costs are not included in total costs) |
| | % of total costs | 24.7 | 10.7 | 6.1 | | |

TYPE OF COSTS IN PERCENTAGE OF TOTAL COSTS

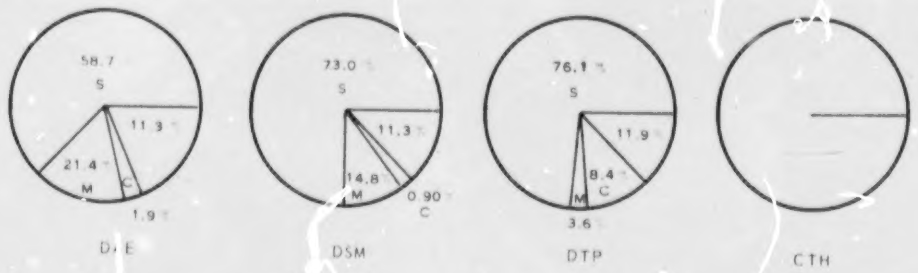


Table 9

COSTS OF RESEARCH

| | Unit | DAE | DSM | DTP | CTH | Comments |
|---|---|---|---|---|---|---|
| Total costs of research | ThSwCr | 1182.2 | 582.3 | 1127.3 | 34298.0 | |
| Research projects | Projects | 30 | 10 | 35 | | |
| | ThSwCr/proj | 39.5 | 58.2 | 36.4 | | |
| Research staff | Scientists | 15 | 11 | 40 | 870 | supervisors + grad. students |
| | ThSwCr/scient | 78.8 | 52.9 | 28.2 | 39.4 | |
| Scientists man-day load | Man-days | 1369 | 880 | 3328 | | |
| | ThSwCr/man-day | 0.86 | 0.66 | 0.34 | | |

Table 10

COST OF AUXILIARY FUNCTIONS

| Function | Unit | DAE | DSM | DTP | CTH |
|---|---|---|---|---|---|
| Total costs of main programme | ThSwCr | 1983.4 | 919.0 | 2937.5 | 84279[1)] |
| Administration (A) | ThSwCr | 131.6 | 74.1 | 181.5 | |
| | % of total costs | 6.6 | 8.1 | 6.2 | |
| Library (L) | ThSwCr | 37.6 | 3.3 | 36.0 | |
| | % of total costs | 1.9 | 0.4 | 1.2 | |
| Reproduction (R) | ThSwCr | 57.6 | 17.9 | 23.0 | |
| | % of total costs | [illegible] | 1.9 | 0.8 | |

1) incl. adm. etc.

PERCENTAGE PRESENTATION

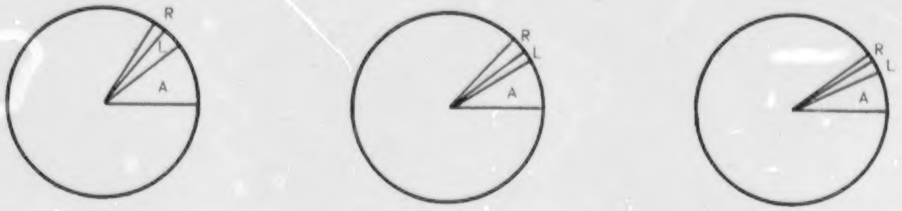


Table 11

TOTAL SALARY COSTS DIVIDED INTO PERSONNEL CATEGORIES

| | | Unit | DAE | DSM | DTP | CTH |
|---|---|---|---|---|---|---|
| Total salary costs | | ThSwCr | 1304.6 | 720.6 | 2802.4 | 70909 |
| Professor<br>Associate professor<br>Assistant professor | (T) | ThSwCr | 259.0 | 165.4 | 1152.2 | 13115 |
| Research assistant<br>University lecturer | | % of total salaries | 19.9 | 23.0 | 41.1 | 18.5 |
| Assistant lecturers<br>grad. student | (A) | ThSwCr | 345.7 | 149.1 | 508.4 | 16449 |
| | | % of total salaries | 26.5 | 20.7 | 18.1 | 29.2 |
| Technical and administrative staff | (S) | ThSwCr | 459.3 | 197.2 | 140.7 | 9293 |
| | | % of total salaries | 35.2 | 27.4 | 5.0 | 13.1 |

PERCENTAGE PRESENTATION

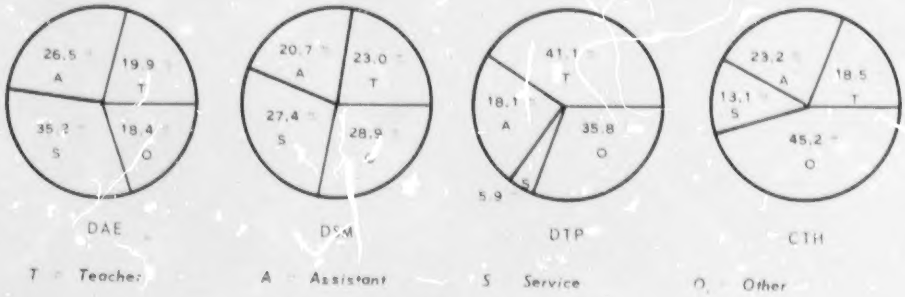
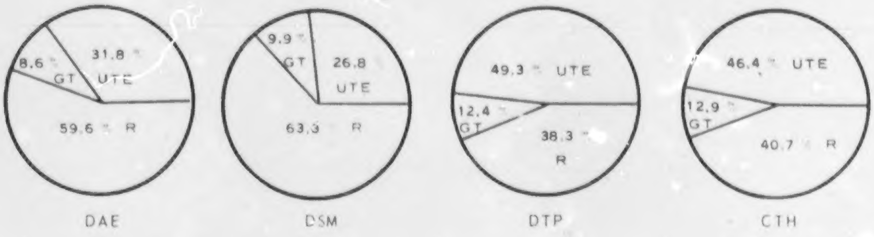


Table 12

TOTAL ECONOMIC VOLUME AND FINANCIAL STRUCTURE OF THE MAIN PROGRAMMES

| Programme | Unit | DAE | DSM | DTP | CTH |
|---|---|---|---|---|---|
| Higher Education and Research | ThSwCr | 1983.4 | 919.1 | 2932.3 | 84279 |
| Undergraduate Technical Education (UTE) | ThSwCr | 631.4 | 246.0 | 1446.1 | 39098 |
| | % of total costs | 31.8 | 26.8 | 49.3 | 46.4 |
| Graduate Training (GT) | ThSwCr | 169.8 | 90.8 | 364.1 | 10883 |
| | % of total costs | 8.6 | 9.9 | 12.4 | 12.9 |
| Technical Research (R) | ThSwCr | 1182.2 | 582.3 | 1127.3 | 34298 |
| | % of total costs | 59.6 | 63.3 | 38.3 | 40.7 |
| Programme grant | ThSwCr | 667.4 | 499.1 | 2327.5 | 59620 |
| | % of total costs | 33.6 | 54.3 | 79.4 | 70.7 |



## Appendix III A

## LIST OF ABBREVIATIONS FOUND IN CHAPTER 8

### Fields of Decision

| | |
|---|---|
| UTE/X | Undergraduate Technical Education/School of Education |
| GT | Graduate Training |
| TR/X | Technical Research/Field of Engineering |
| Ec | Economy |
| S | Staff |
| EA | Educational Administration |
| RA | Research Administration |
| PAB | Planning and Administration of Buildings |
| PAE | Planning and Administration of Equipment |

### Boards, Committees, Persons Responsible for Decisions

| | |
|---|---|
| CA | Central Administration of CTH |
| CC | Customer of Commission |
| CCGT | Central Committee of Graduate Training |
| CCR | Central Committee of Research |
| CCUT | Central Committee of Undergraduate Technical Education |
| CRX | Committee of Research for Engineering Field X |
| CTH-BU | Board of University at CTH |
| CUT X | Committee of Undergraduate Technical Education for School X |
| DIV | Division (Head of Division, Board of Division, etc.) |
| EXAM | Examiner of Course |
| G | Government |
| KBS | National Board of Building |
| LUP | The Planning Committee for Building and Equipment for the Swedish Universities |
| NAB | Swedish National Audit Bureau |
| OCU | Office of the Chancellor of the Swedish Universities |
| PROJL | Project Leader |

| | |
|---|---|
| RC | Research Councils |
| SUP | Supervisor |
| UUH | The Equipment Board for the Swedish Universities |

## Documents of Information

| | |
|---|---|
| CaL-Schedule | Course and Lecture Schedule |
| PB-PROP | Programme Budget Proposal |
| RRL | Royal Regulation Letter |
| SEA-system | The State Economic Administrative System |
| TRX-budget | Budget for Engineering Field X |
| TRX-plan | Plan for activities within Engineering Field X |
| TRX-request | Budget Request for Engineering Field X |

## Other Abbreviations

| | |
|---|---|
| gc | Graduate courses |
| GS | Graduate student |
| uc | Undergraduate courses |

Abbreviations not found in this list will be found in a complete list of abbreviations in Appendix IV B.

Append

FIELDS OF DECISION VERSU

| Field of Decision / Level of Decision | 1X Undergraduate Technical Education/School (UTE/X) | 20 Graduate Training (GT) | 3X Technical Research/ Engineering/Field (TR/X) | 4 Economy (Ec |
|---|---|---|---|---|
| Long-term Planning (3-5 years) | 1X1<br>Long-term planning for the school | 201<br>Long-term planning for GT Construction of individual work programmes | 3X1<br>Long-term planning for the engineering field X | 4<br>Long-term economic planning |
| Annual Planning | 1X2<br>Planning of Cal-schedule<br>Adjustment of the course programmes and budgets<br>Allocation of the UTE-grant | 202<br>Current planning for graduate students<br>Allocation of GT-grant | 3X2<br>Construction of the division research plan<br>Allocation of research grant to X | 4<br>Budgeting |
| Short-term Planning (less than one year) | 1X3<br>Division planning of courses | 203<br>Current planning of graduate courses | 3X3<br>Disposal of research appropriations | 4<br>Final allocatio of grants<br>Adjustment of budgets |
| Operational Decisions | 1X4<br>Planning of individual courses and thesis work | 204<br>Planning of individual graduate courses | 3X4<br>Detailed planning of projects | 4<br>Classification of accounts<br>Routines for accounting |
| Current Activities | 1X5<br>The teaching of courses<br>Thesis work | 205<br>Teaching of courses Special GT activities<br>Thesis work | 3X5<br>Technical research | 4<br>Cash-and cost accounting |
| Control, Follow-up | 1X6<br>Examination follow up | 206<br>Examination<br>Public discussion of thesis | 3X6<br>Process of reporting | 4<br>Auditing the budgets<br>Balancing the books |

III B

EVELS OF DECISION-MAKING

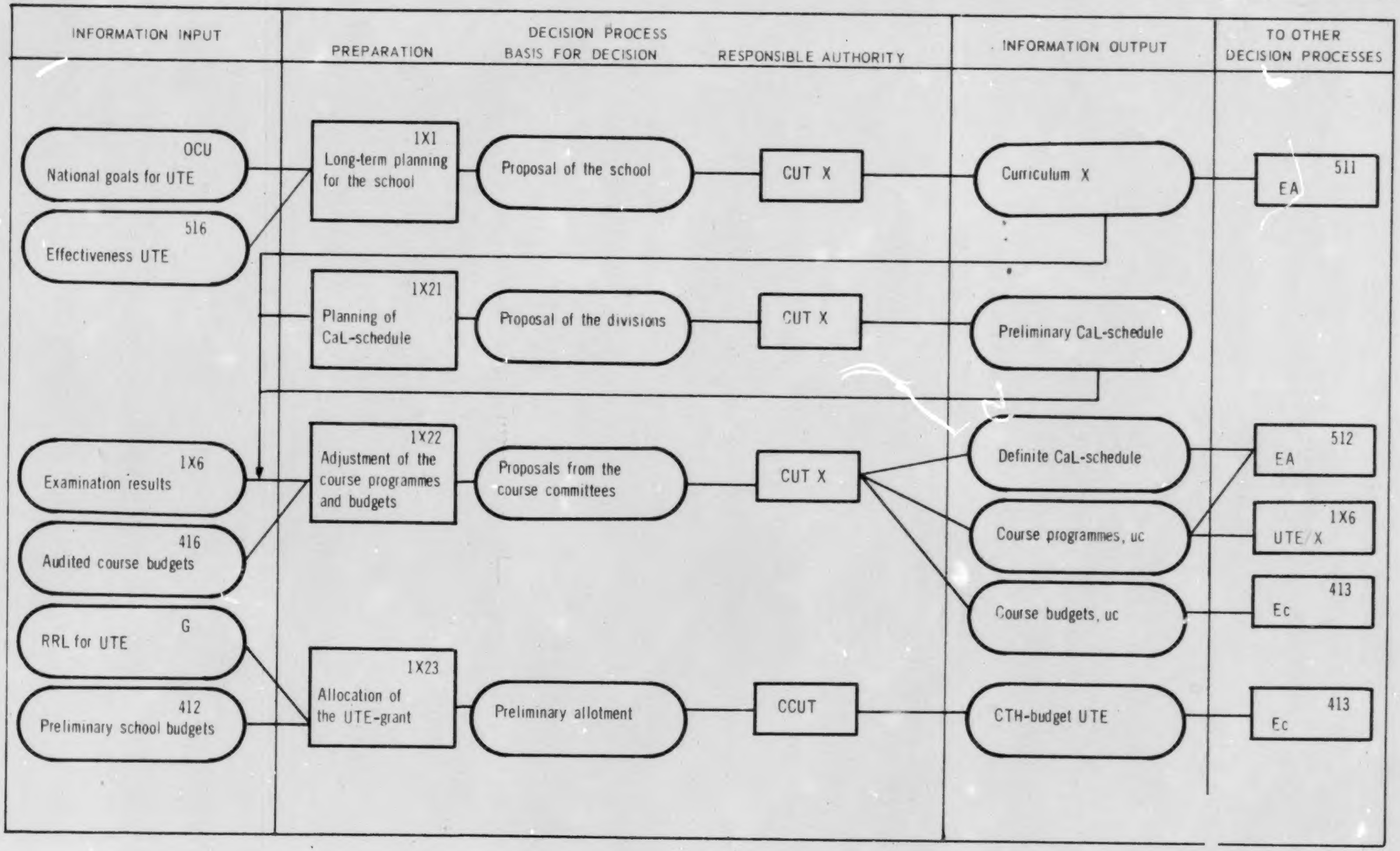
| 42<br>aff<br>(S) | 51<br>Educational Administration<br>(EA) | 52<br>Research Administration<br>(RA) | 53<br>Planning and Administration of Building<br>(PAB) | 54<br>Planning and Administration of Equipment<br>(PAE) |
|---|---|---|---|---|
| 421<br>mmary of re-<br>ests for<br>fices | 511<br>Calculation of need resources for UTE and GT | 521<br>Long-term calculations of needs for resources | 531<br>Long-term space planning | 541<br>Long-term planning of investments for equipment |
| 422<br>rrent planning<br>aff | 512<br>Editing education catalogues | 522<br>Annual report of current research activities | 532<br>Registration of current building projects<br>Allotment of space | 542<br>Current investment planning<br>Allocation of resources |
| 423<br>mmary of need<br>r new employ-<br>nts | 513<br>Working out schedules for lectures and exams<br>Special education activities | 523<br>Allocation of resources for special research activities | 533<br>Planning for using shared rooms | 543<br>Planning of use of available equipment |
| 424<br>nsiderations<br>ncerning new<br>ployment | 514<br>Detailed planning of special activities | 524<br>Planning of CTH-projects Working out PR-programme for CTH | 534<br>Decisions on rentals and hiring of space | 544<br>Decision purchase rentals, hiring |
| 425<br>deployment<br>staff | 515<br>Registration of grades and exams | 525<br>Administration of projects and commissions<br>Contacts and information arrangements | 535<br>Administration of buildings<br>Registration of rooms | 545<br>Purchase, renting, hiring of equipment registration |
| 426<br>me registration<br>aff registra-<br>on<br>llow up per-<br>nnel capacity | 516<br>Statistical analysis<br>Follow up of effectiveness | 526<br>Collection and follow up of position reports<br>Control of effectiveness | 536<br>Follow up of building plans<br>Control of room exploitation | 546<br>Follow up of investment plans<br>Control of exploitation of equipment |

Appendix III C

## HIERARCHICAL MODEL OF DECISION

Hierarchical Model of Decision (page 1)

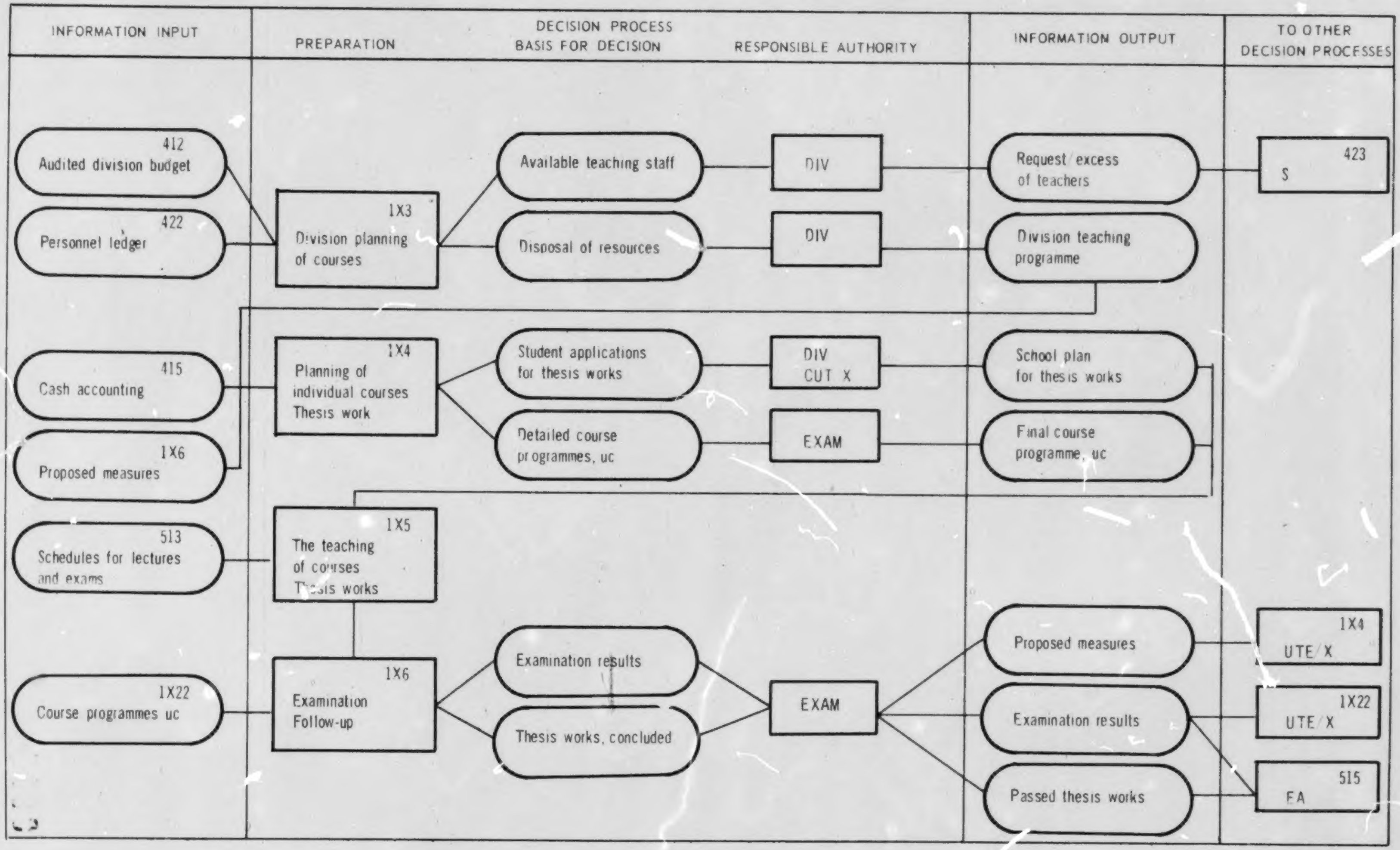
| | | Code | Page |
|---|---|---|---|
| Field of Decision | Abbr. | **Kod** | **Sida** |
| Undergraduate Technical Education/School | UTE/X | **1X** | **1** |



INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
OCU National goals for UTE
516 Effectiveness UTE
1X1 Long-term planning for the school
Proposal of the school
CUT X
Curriculum X
511 EA
1X21 Planning of CaL-schedule
Proposal of the divisions
CUT X
Preliminary CaL-schedule
1X6 Examination results
416 Audited course budgets
1X22 Adjustment of the course programmes and budgets
Proposals from the course committees
CUT X
Definite CaL-schedule
Course programmes, uc
Course budgets, uc
512 EA
1X6 UTE/X
413 Ec
G RRL for UTE
412 Preliminary school budgets
1X23 Allocation of the UTE-grant
Preliminary allotment
CCUT
CTH-budget UTE
413 Ec

Hierarchical Model of Decision (page 2)

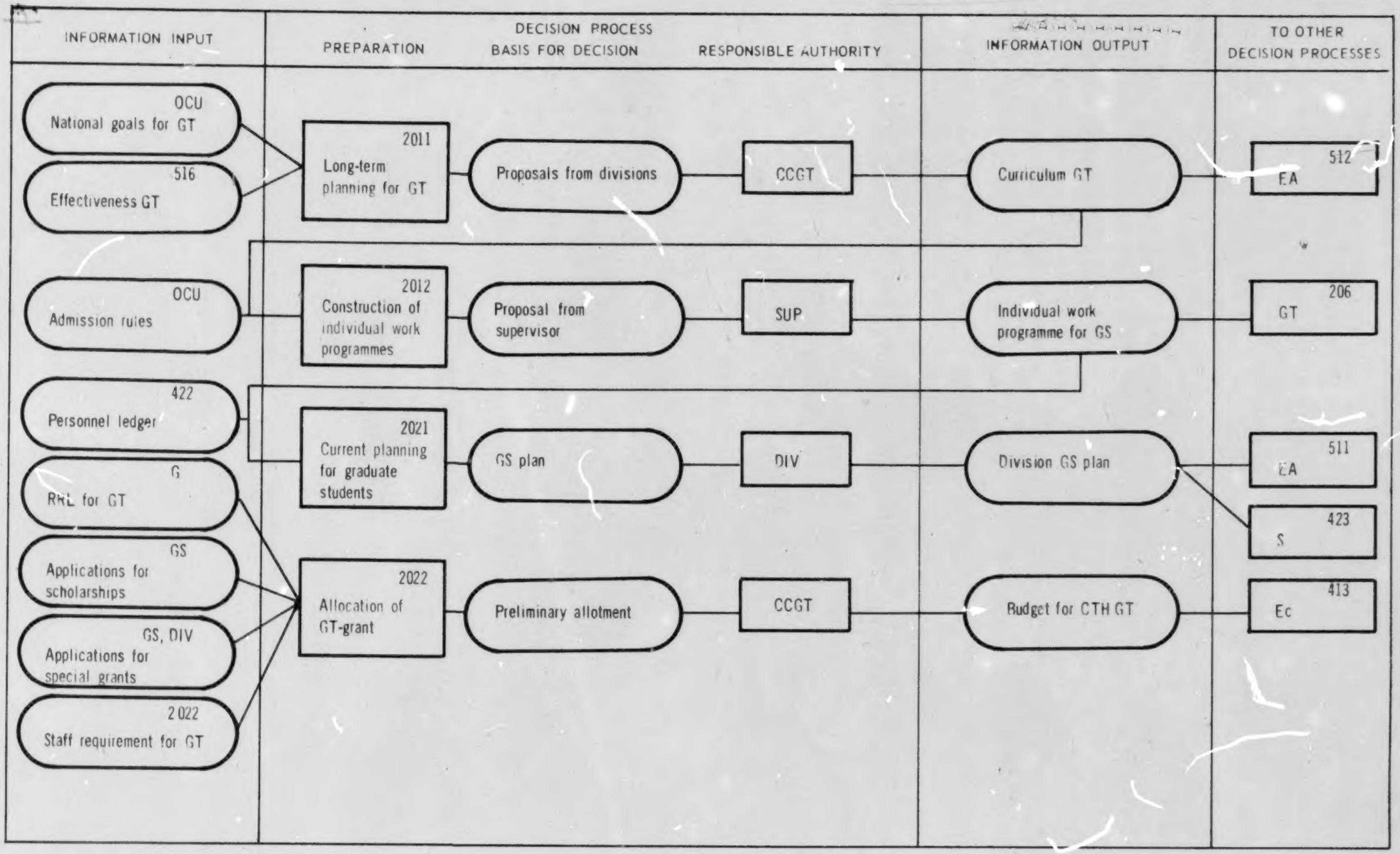
| Field of Decision | Abbr. | Code<br>**Kod** | Page<br>**Sida** |
|---|---|---|---|
| Undergraduate Technical Education/School | UTE/X | **1X** | **2** |



INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
412 Audited division budget
422 Personnel ledger
415 Cash accounting
1X6 Proposed measures
513 Schedules for lectures and exams
1X22 Course programmes uc
1X3 Division planning of courses
1X4 Planning of individual courses Thesis work
1X5 The teaching of courses Thesis works
1X6 Examination Follow-up
Available teaching staff
Disposal of resources
Student applications for thesis works
Detailed course programmes, uc
Examination results
Thesis works, concluded
DIV
DIV
DIV CUT X
EXAM
EXAM
Request/excess of teachers
Division teaching programme
School plan for thesis works
Final course programme, uc
Proposed measures
Examination results
Passed thesis works
423 S
1X4 UTE/X
1X22 UTE/X
515 FA

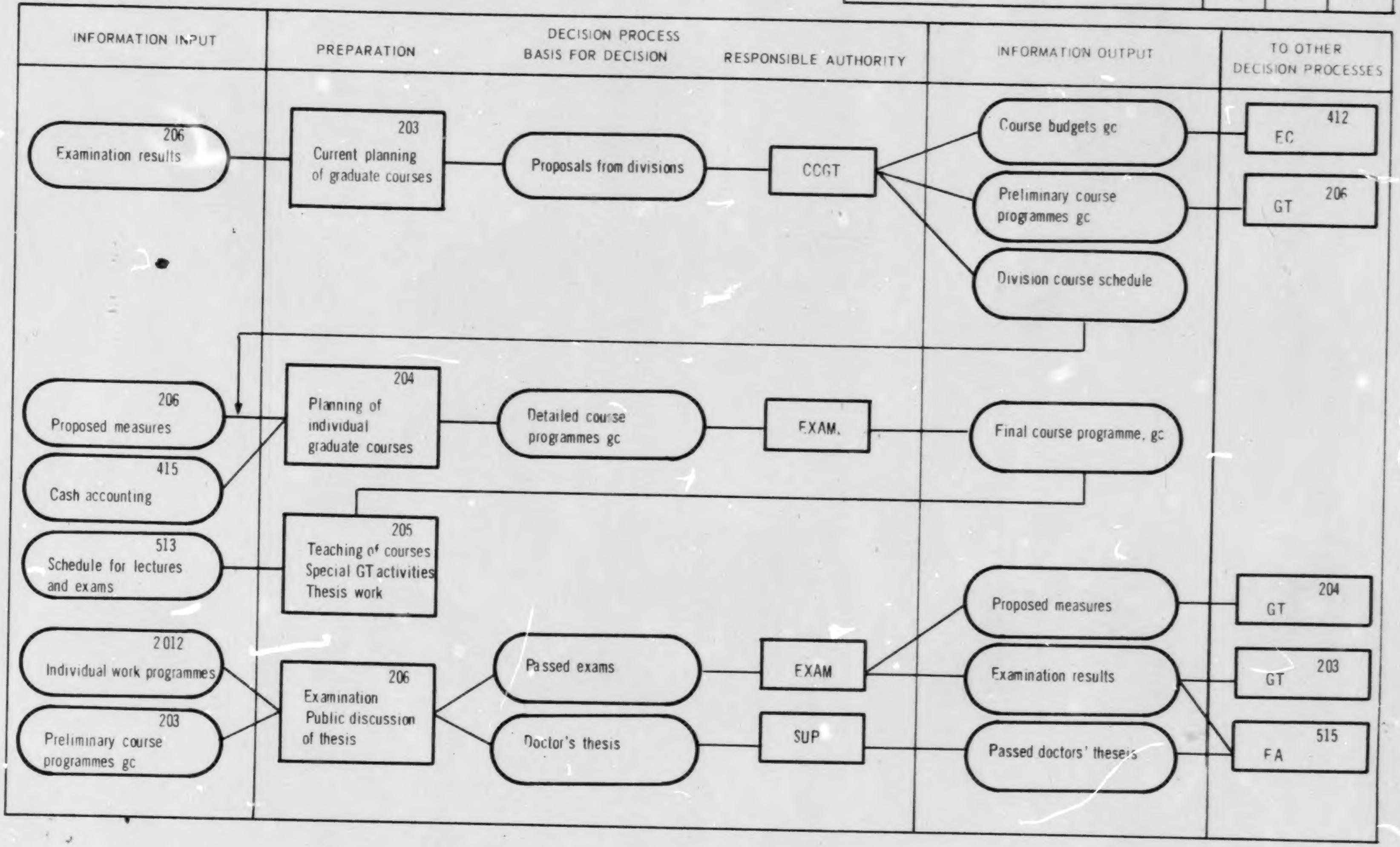
Hierarchical Model of Decision (page 3)

| Field of Decision | Abbr. | Code<br>**Kod** | Page<br>**Sida** |
|---|---|---|---|
| Graduate Training | GT | **20** | **1** |


INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
OCU National goals for GT
516 Effectiveness GT
OCU Admission rules
422 Personnel ledger
G RRL for GT
GS Applications for scholarships
GS, DIV Applications for special grants
2022 Staff requirement for GT
2011 Long-term planning for GT
2012 Construction of individual work programmes
2021 Current planning for graduate students
2022 Allocation of GT-grant
Proposals from divisions
Proposal from supervisor
GS plan
Preliminary allotment
CCGT
SUP
DIV
CCGT
Curriculum GT
Individual work programme for GS
Division GS plan
Budget for CTH GT
512 EA
206 GT
511 EA
423 S
413 Ec

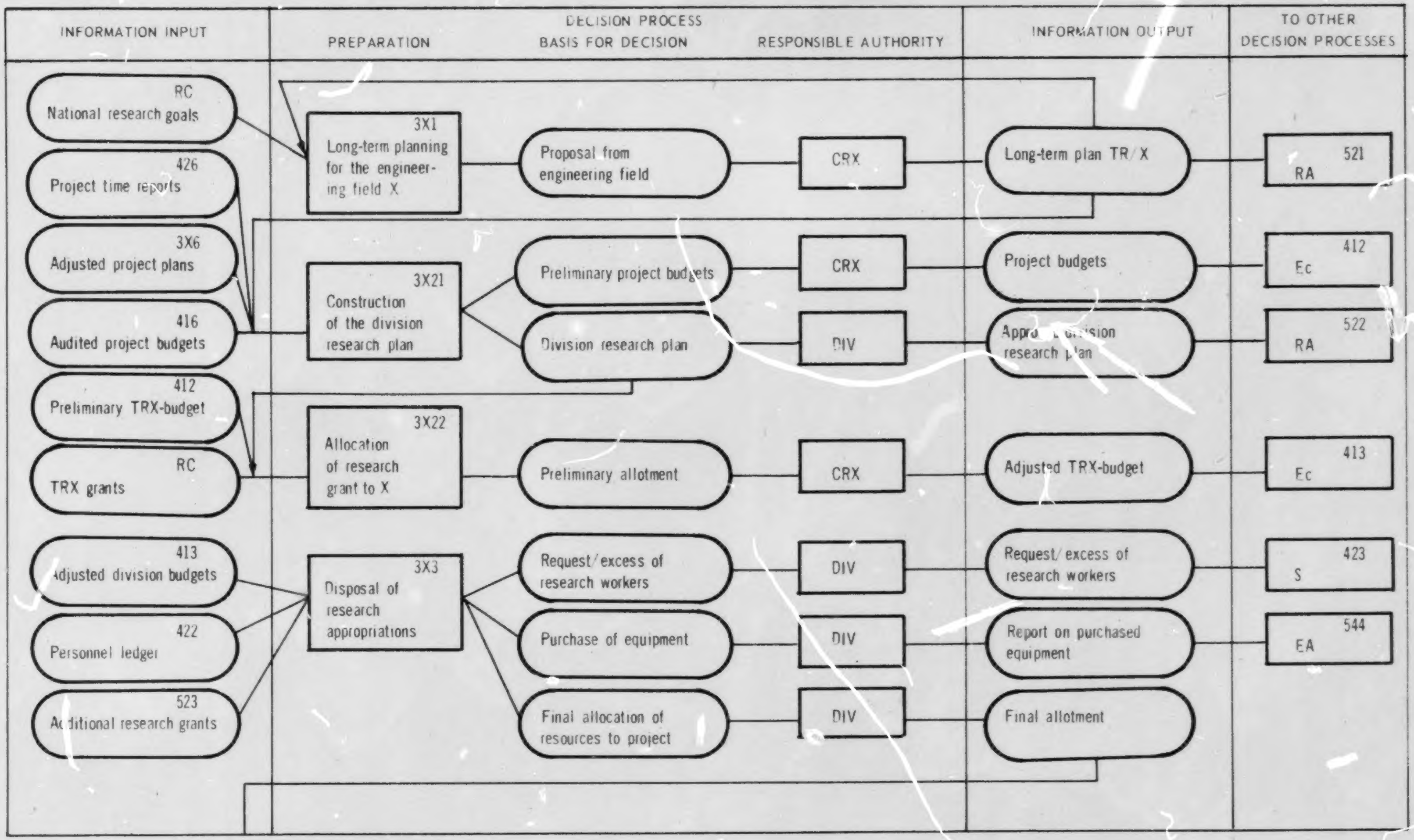
Hierarchical Model of Decision (page 4)

| Field of Decision | Abbr. | Code<br>**Kod** | Page<br>**Sida** |
|---|---|---|---|
| Graduate Training | GT | **20** | **2** |


INFORMATION INPUT
PREPARATION
DECISION PROCESS
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
206 Examination results
203 Current planning of graduate courses
Proposals from divisions
CCGT
Course budgets gc
Preliminary course programmes gc
Division course schedule
EC 412
GT 206
206 Proposed measures
415 Cash accounting
513 Schedule for lectures and exams
2012 Individual work programmes
203 Preliminary course programmes gc
204 Planning of individual graduate courses
205 Teaching of courses Special GT activities Thesis work
206 Examination Public discussion of thesis
Detailed course programmes gc
Passed exams
Doctor's thesis
EXAM.
EXAM
SUP
Final course programme, gc
Proposed measures
Examination results
Passed doctors' theses
GT 204
GT 203
FA 515

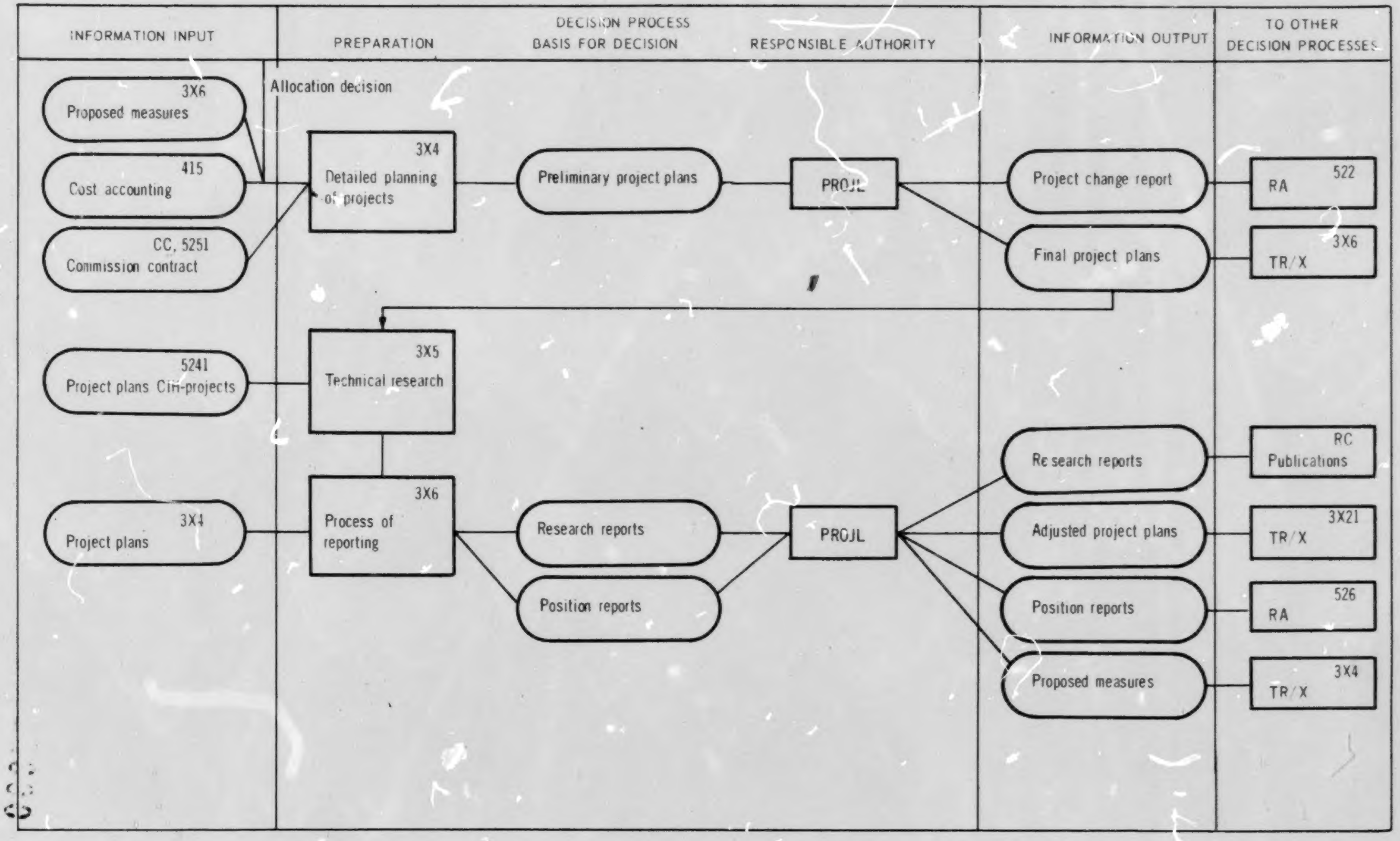
Hierarchical Model of Decision (page 5)

| Field of Decision | Abbr. | Code<br>Kod | Page<br>Sida |
|---|---|---|---|
| Technical Research/ Engineering Field | TR/X | 3X | 1 |



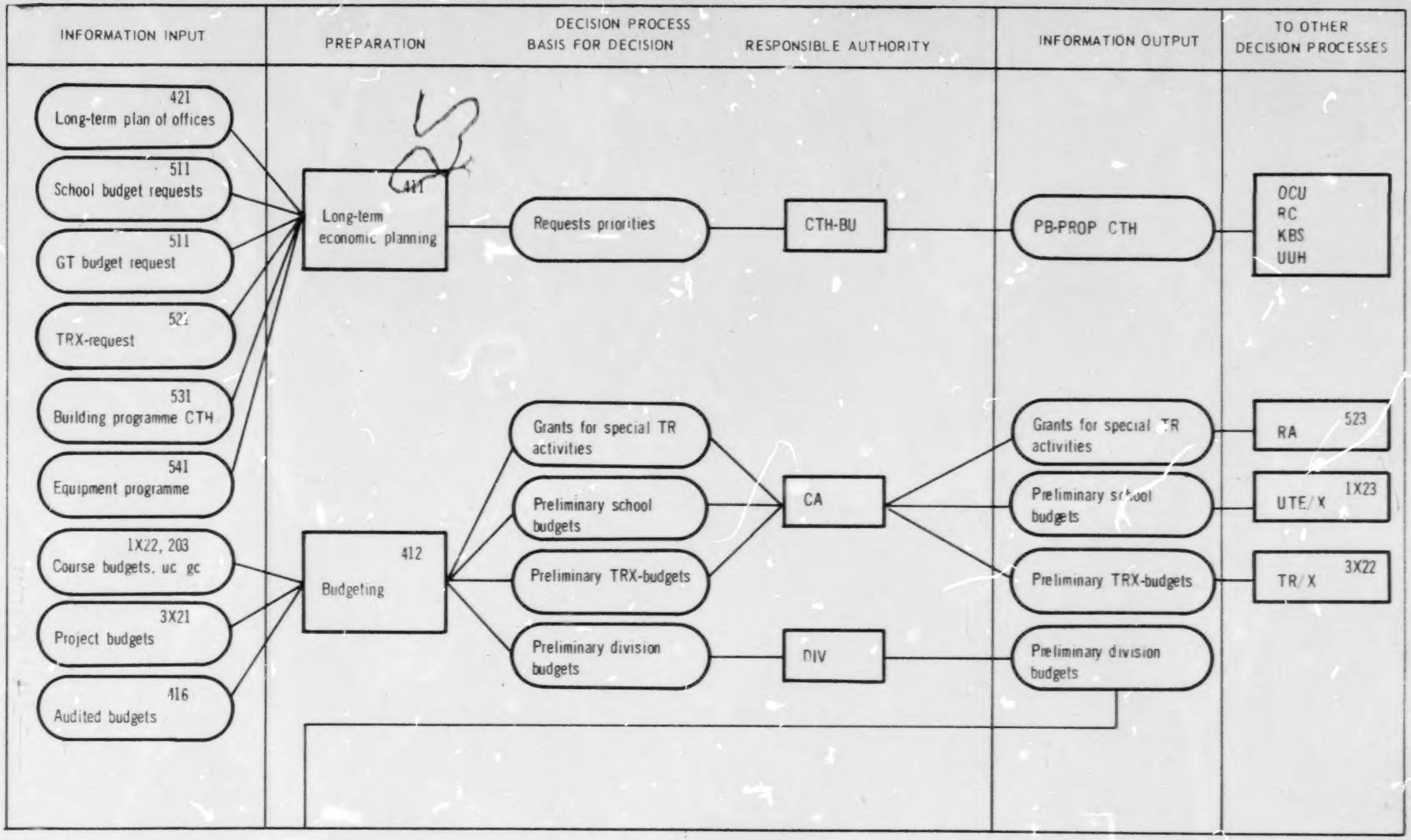
INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
RC National research goals
426 Project time reports
3X6 Adjusted project plans
416 Audited project budgets
412 Preliminary TRX-budget
RC TRX grants
413 Adjusted division budgets
422 Personnel ledger
523 Additional research grants
3X1 Long-term planning for the engineering field X
3X21 Construction of the division research plan
3X22 Allocation of research grant to X
3X3 Disposal of research appropriations
Proposal from engineering field
Preliminary project budgets
Division research plan
Preliminary allotment
Request/excess of research workers
Purchase of equipment
Final allocation of resources to project
CRX
CRX
DIV
CRX
DIV
DIV
DIV
Long-term plan TR/X
Project budgets
Approved division research plan
Adjusted TRX-budget
Request/excess of research workers
Report on purchased equipment
Final allotment
521 RA
412 Ec
522 RA
413 Ec
423 S
544 EA

| Hierarchical Model of Decision (page 6) | | Code | Page |
|---|---|---|---|
| Field of Decision | Abbr. | Kod | Sida |
| Technical Research/Engineering Field | TR/X | 3X | 2 |


INFORMATION INPUT
PREPARATION
DECISION PROCESS
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
Allocation decision
3X6 Proposed measures
415 Cost accounting
CC, 5251 Commission contract
3X4 Detailed planning of projects
Preliminary project plans
PROJL
Project change report
Final project plans
522 RA
3X6 TR/X
5241 Project plans CIH-projects
3X5 Technical research
3X4 Project plans
3X6 Process of reporting
Research reports
Position reports
PROJL
Research reports
Adjusted project plans
Position reports
Proposed measures
RC Publications
3X21 TR/X
526 RA
3X4 TR/X

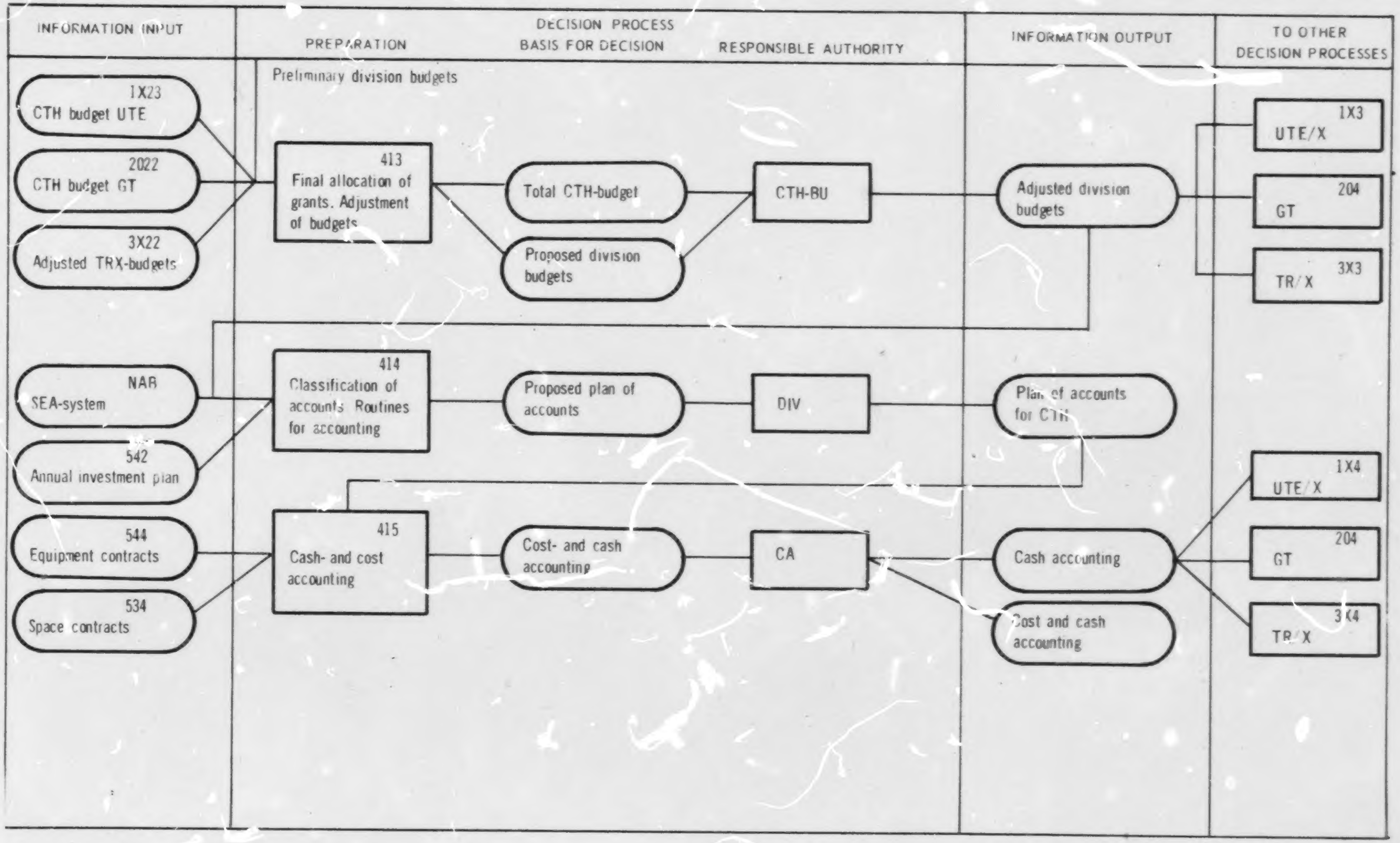
Hierarchical Model of Decision (page 7)

| Field of Decision | Abbr. | Code<br>Kod | Page<br>Sida |
|---|---|---|---|
| Economy | Ec | 41 | 1 |


INFORMATION INPUT
PREPARATION
DECISION PROCESS
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
421 Long-term plan of offices
511 School budget requests
511 GT budget request
522 TRX-request
531 Building programme CTH
541 Equipment programme
1X22, 203 Course budgets, uc gc
3X21 Project budgets
416 Audited budgets
411 Long-term economic planning
412 Budgeting
Requests priorities
Grants for special TR activities
Preliminary school budgets
Preliminary TRX-budgets
Preliminary division budgets
CTH-BU
CA
DIV
PB-PROP CTH
Grants for special TR activities
Preliminary school budgets
Preliminary TRX-budgets
Preliminary division budgets
OCU
RC
KBS
UUH
RA 523
UTE/X 1X23
TR/X 3X22

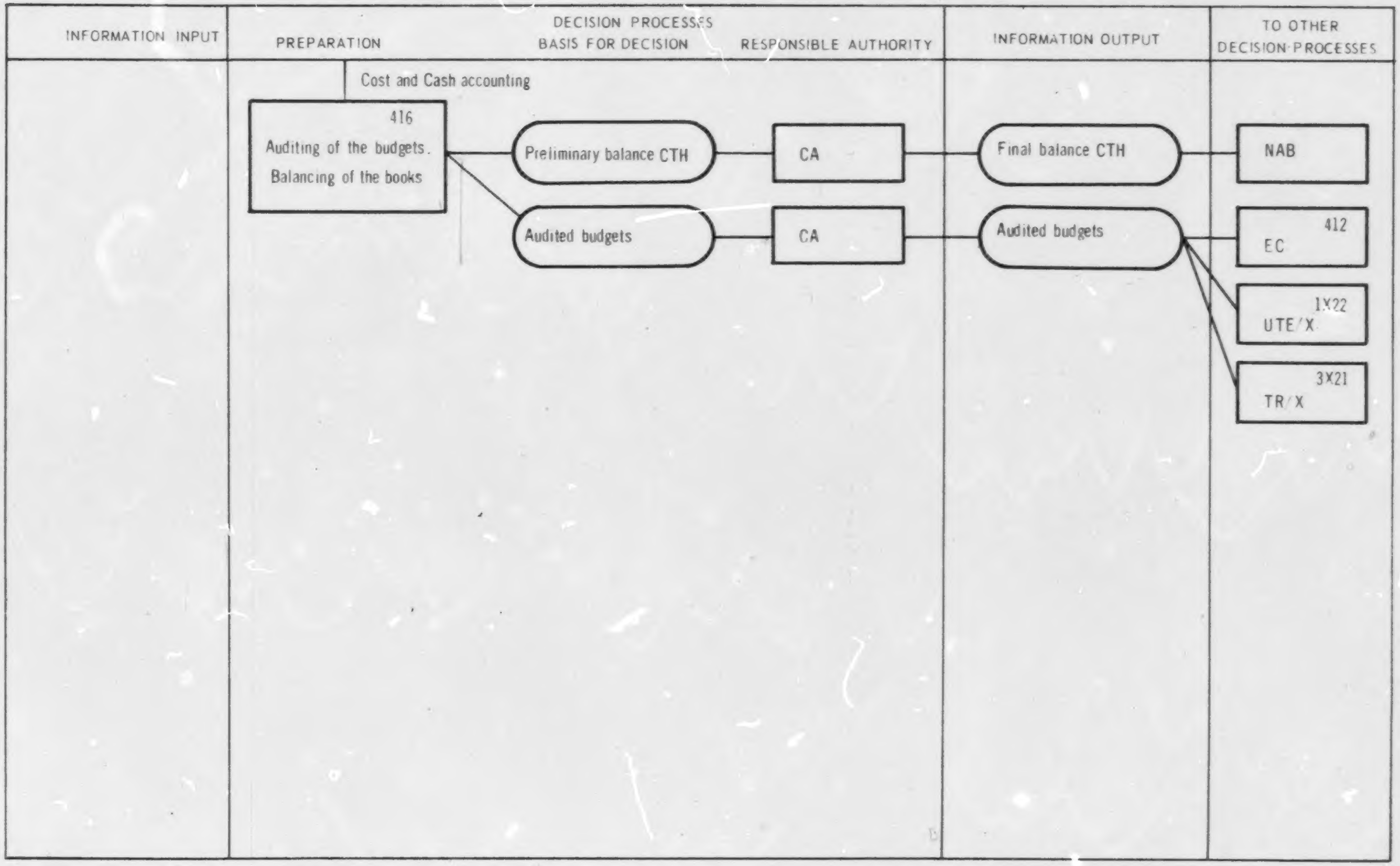
Hierarchical Model of Decision (page 9)

|  |  | Code | Page |
|---|---|---|---|
| Field of Decision | Abbr. | Kod | Sida |
| Economy | Ec | 41 | 2 |


INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
Preliminary division budgets
1X23
CTH budget UTE
2022
CTH budget GT
3X22
Adjusted TRX-budgets
413
Final allocation of grants. Adjustment of budgets
Total CTH-budget
Proposed division budgets
CTH-BU
Adjusted division budgets
1X3
UTE/X
204
GT
3X3
TR/X
NAB
SEA-system
542
Annual investment plan
414
Classification of accounts. Routines for accounting
Proposed plan of accounts
DIV
Plan of accounts for CTH
544
Equipment contracts
534
Space contracts
415
Cash- and cost accounting
Cost- and cash accounting
CA
Cash accounting
Cost and cash accounting
1X4
UTE/X
204
GT
3X4
TR/X

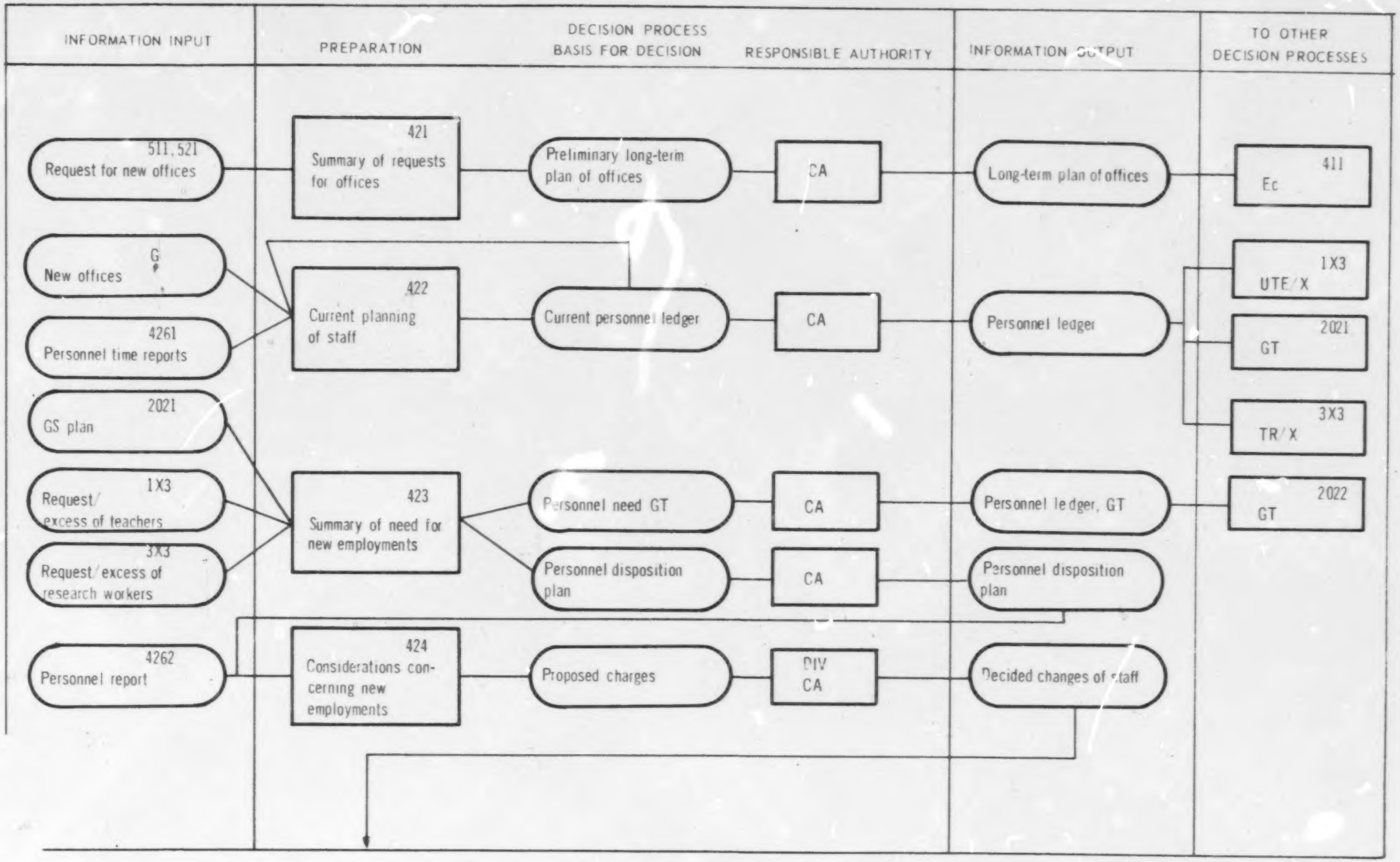
Hierarchical Model of Decision (page 9)

| Field of Decision | Abbr. | Code<br>**Kod** | Page<br>**Sida** |
|---|---|---|---|
| Economy | Ec | **41** | **3** |


INFORMATION INPUT
DECISION PROCESSES
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION-PROCESSES
Cost and Cash accounting
416
Auditing of the budgets.
Balancing of the books
Preliminary balance CTH
Audited budgets
CA
CA
Final balance CTH
Audited budgets
NAB
412
EC
1X22
UTE/X
3X21
TR/X

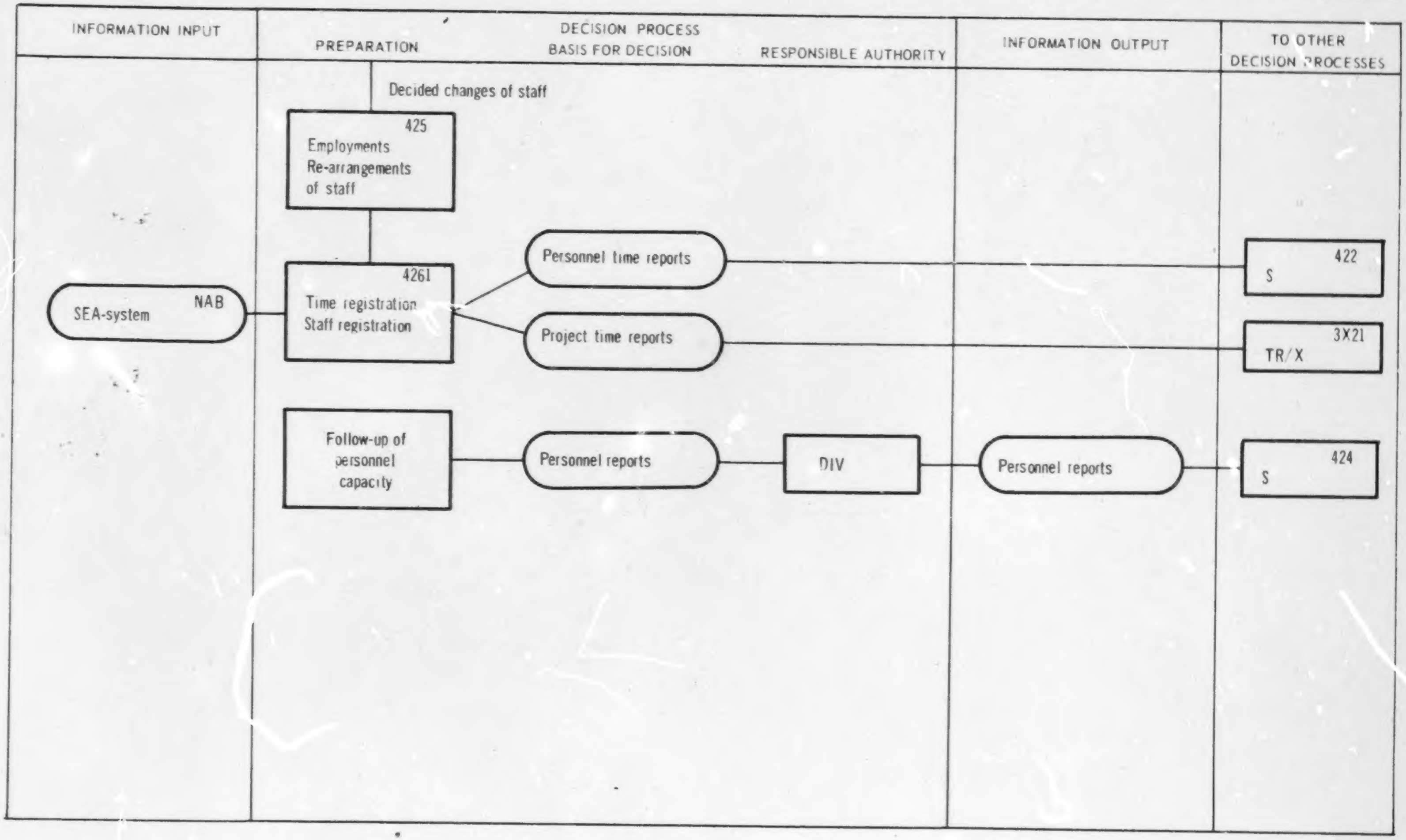
Hierarchical Model of Decision (page 10)

| Field of decision | Abbr. | Code<br>**Kod** | Page<br>**Sida** |
|---|---|---|---|
| Staff | S | **42** | **1** |


INFORMATION INPUT
PREPARATION
DECISION PROCESS
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
511, 521
Request for new offices
G
New offices
4261
Personnel time reports
2021
GS plan
1X3
Request/ excess of teachers
3X3
Request/excess of research workers
4262
Personnel report
421
Summary of requests for offices
422
Current planning of staff
423
Summary of need for new employments
424
Considerations concerning new employments
Preliminary long-term plan of offices
Current personnel ledger
Personnel need GT
Personnel disposition plan
Proposed charges
CA
CA
CA
CA
DIV
CA
Long-term plan of offices
Personnel ledger
Personnel ledger, GT
Personnel disposition plan
Decided changes of staff
411
Ec
1X3
UTE/X
2021
GT
3X3
TR/X
2022
GT

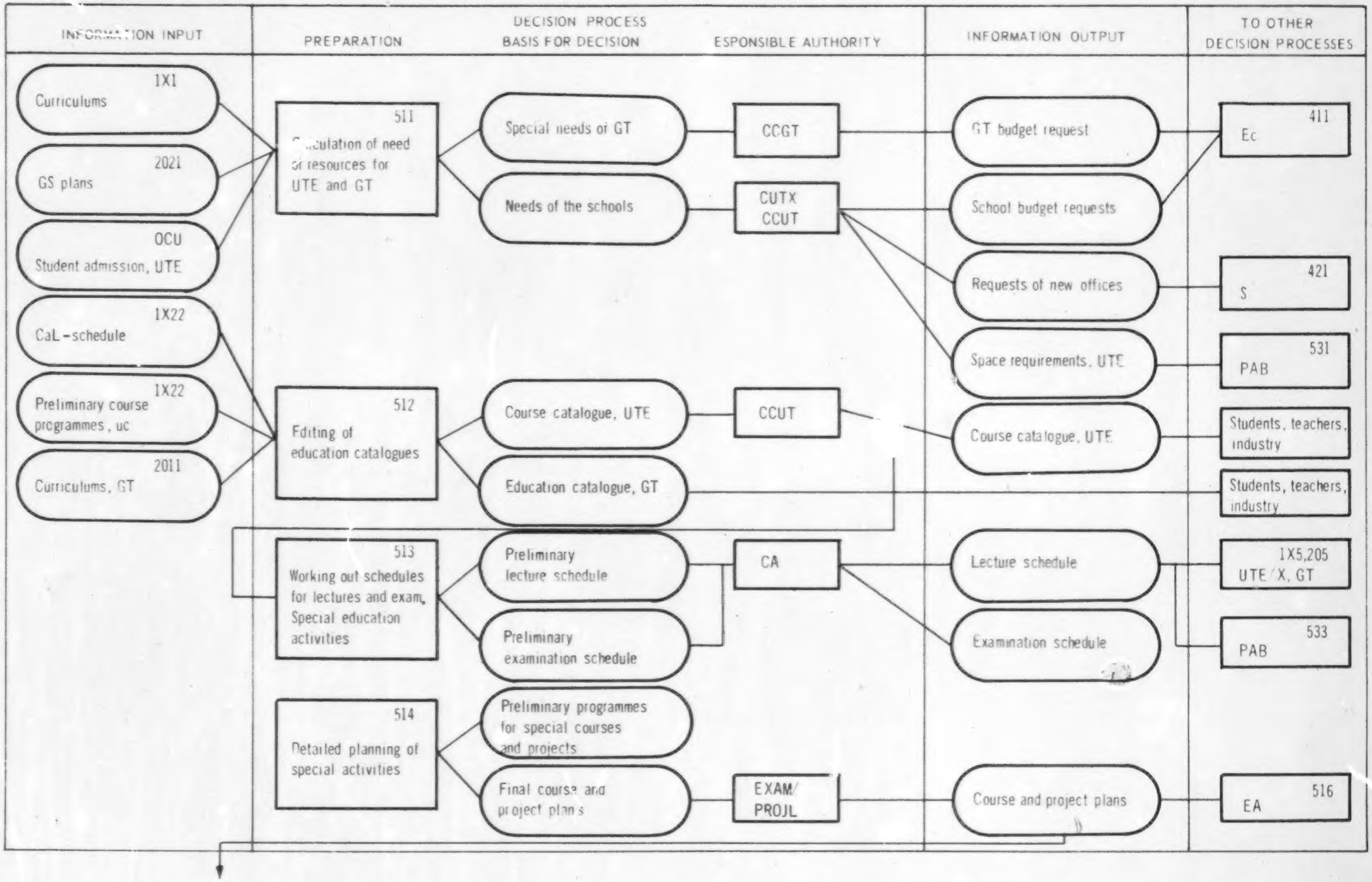
Hierarchical Model of Decision (page 11)

|  |  | Code | Page |
|---|---|---|---|
| Field of Decision | Abbr. | **Kod** | **Sida** |
| Staff | S | **42** | **2** |


INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
Decided changes of staff
425
Employments Re-arrangements of staff
SEA-system
NAB
4261
Time registration Staff registration
Personnel time reports
Project time reports
S
422
TR/X
3X21
Follow-up of personnel capacity
Personnel reports
DIV
Personnel reports
S
424

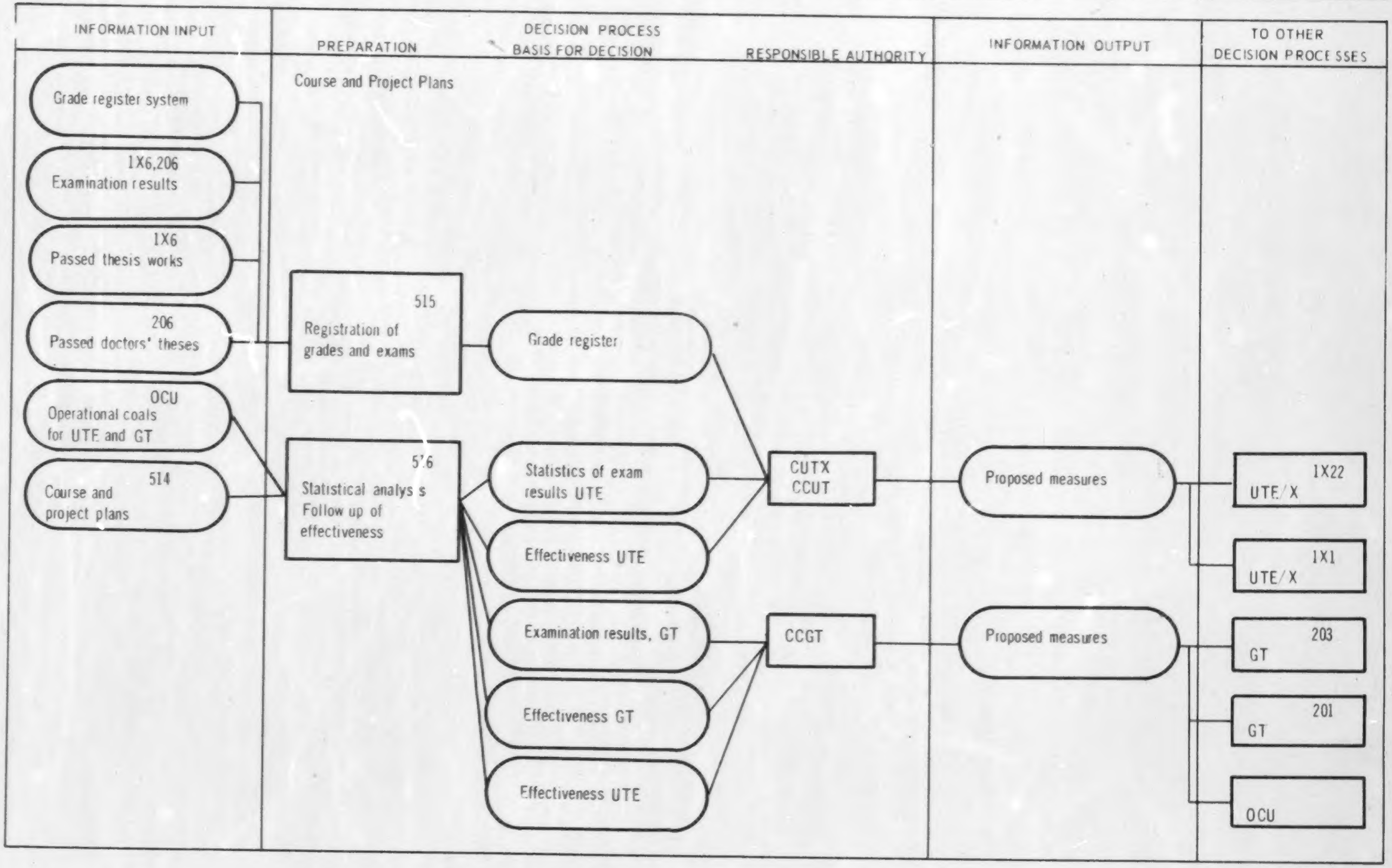
Hierarchical Model of Decision (page 12)

| Field of Decision | Abbr. | Code<br>**Kod** | Page<br>**Sida** |
|---|---|---|---|
| Educational Administration | EA | **51** | **1** |


INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
ESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
1X1 Curriculums
2021 GS plans
OCU Student admission, UTE
1X22 CaL-schedule
1X22 Preliminary course programmes, uc
2011 Curriculums, GT
511 Calculation of need of resources for UTE and GT
512 Editing of education catalogues
513 Working out schedules for lectures and exam, Special education activities
514 Detailed planning of special activities
Special needs of GT
Needs of the schools
Course catalogue, UTE
Education catalogue, GT
Preliminary lecture schedule
Preliminary examination schedule
Preliminary programmes for special courses and projects
Final course and project plans
CCGT
CUTX CCUT
CCUT
CA
EXAM/ PROJL
GT budget request
School budget requests
Requests of new offices
Space requirements, UTE
Course catalogue, UTE
Lecture schedule
Examination schedule
Course and project plans
411 Ec
421 S
531 PAB
Students, teachers, industry
Students, teachers, industry
1X5,205 UTE/X, GT
533 PAB
516 EA

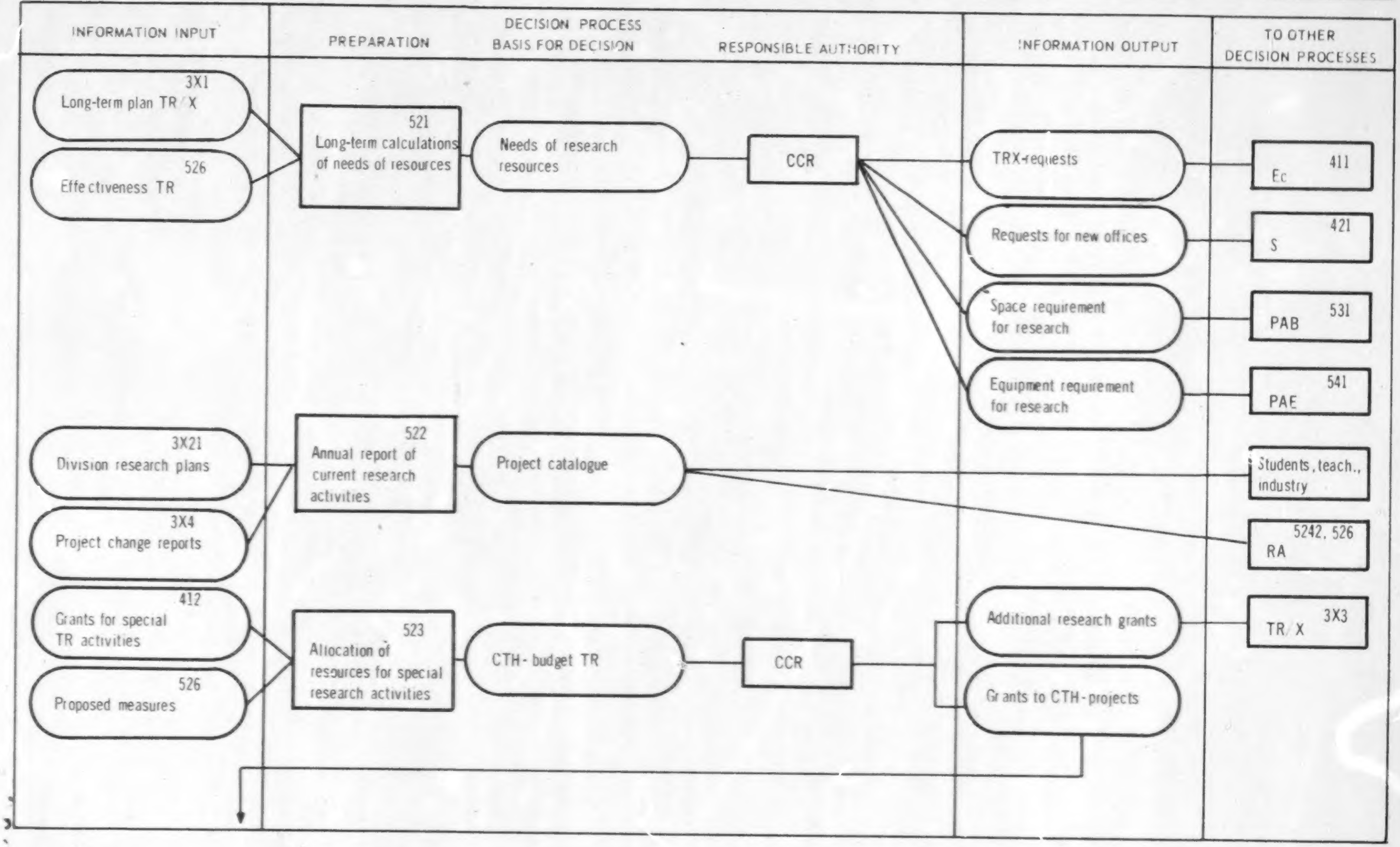
Hierarchical Model of Decision (page 13)

|  |  | Code | Page |
|---|---|---|---|
| Field of Decision | Abbr.' | **Kod** | **Sida** |
| Educational Administration | EA | **51** | **2** |


INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
Course and Project Plans
Grade register system
1X6,206 Examination results
1X6 Passed thesis works
206 Passed doctors' theses
OCU Operational coals for UTE and GT
514 Course and project plans
515 Registration of grades and exams
5'6 Statistical analys s Follow up of effectiveness
Grade register
Statistics of exam results UTE
Effectiveness UTE
Examination results, GT
Effectiveness GT
Effectiveness UTE
CUTX CCUT
CCGT
Proposed measures
Proposed measures
1X22 UTE/X
1X1 UTE/X
203 GT
201 GT
OCU

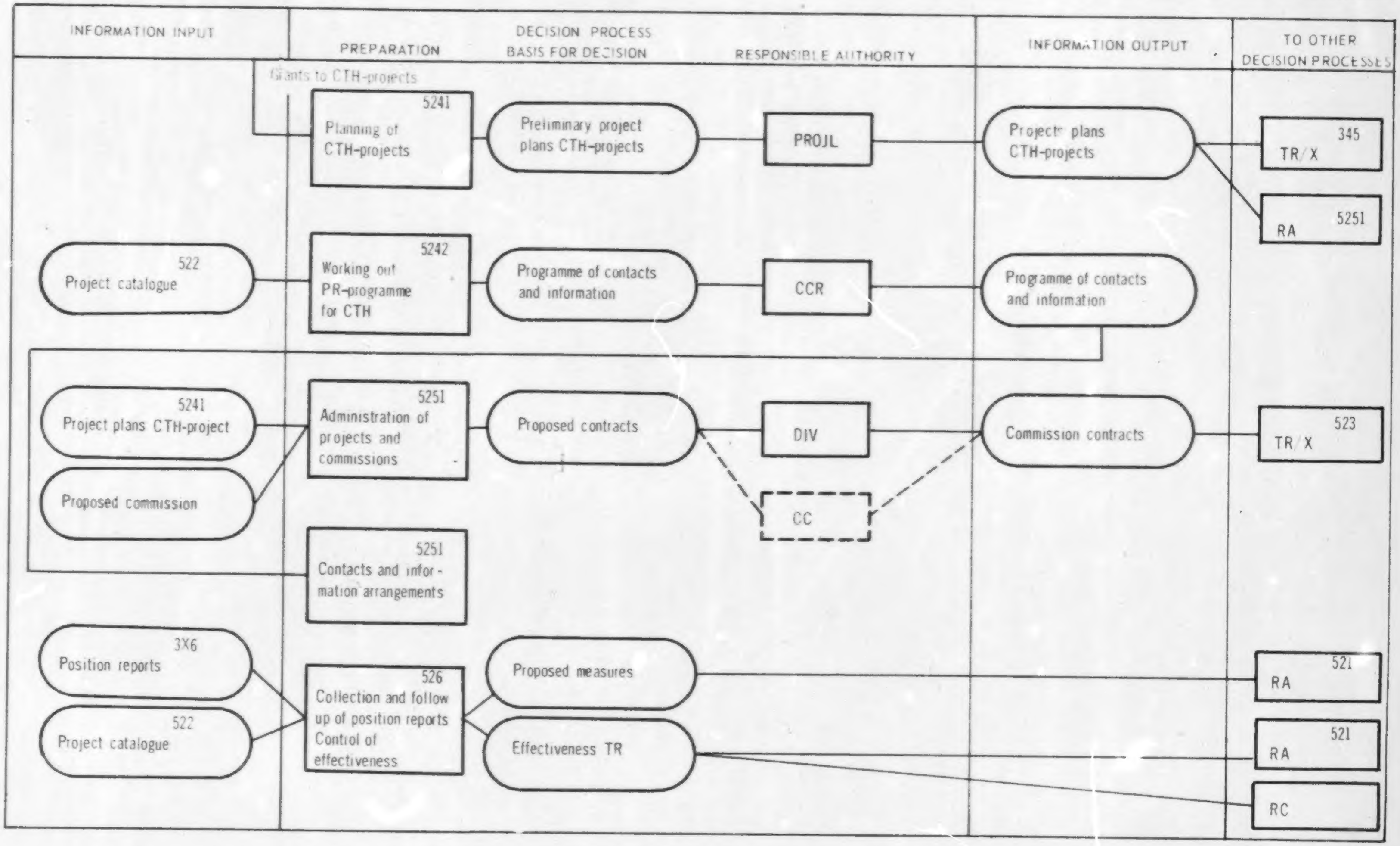
Hierarchical Model of Decision (page 14)

| Field of Decision | Abbr. | Code<br>**Kod** | Page<br>**Sida** |
|---|---|---|---|
| Research Administration | RA | **52** | **1** |


INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
3X1
Long-term plan TR/X
526
Effectiveness TR
521
Long-term calculations of needs of resources
Needs of research resources
CCR
TRX-requests
Requests for new offices
Space requirement for research
Equipment requirement for research
411
Ec
421
S
531
PAB
541
PAE
3X21
Division research plans
3X4
Project change reports
522
Annual report of current research activities
Project catalogue
Students, teach., industry
5242, 526
RA
412
Grants for special TR activities
526
Proposed measures
523
Allocation of resources for special research activities
CTH-budget TR
CCR
Additional research grants
Grants to CTH-projects
3X3
TR/X

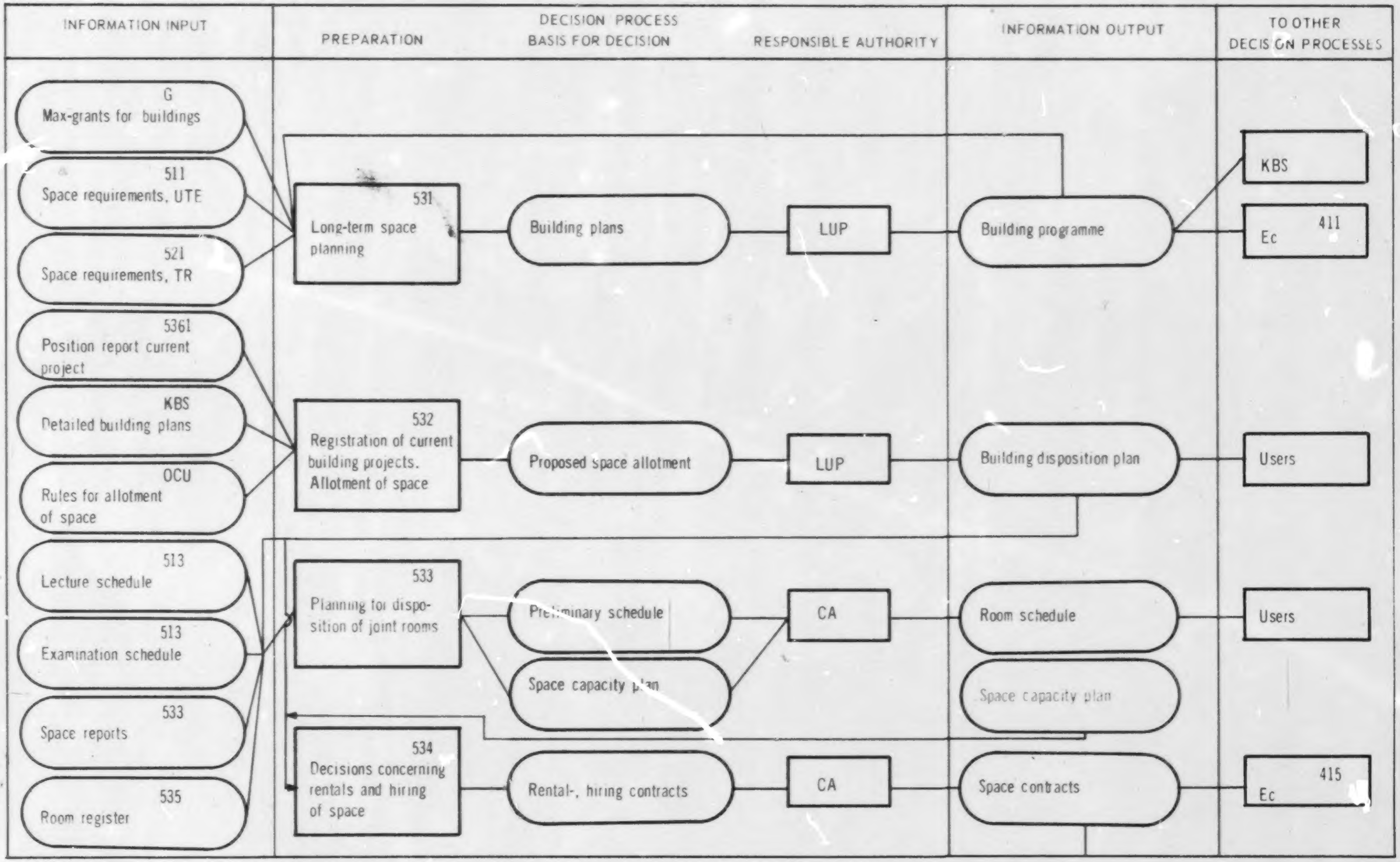
Hierarchical Model of Decision (page 15)

| Field of Decision | Abbr. | Code<br>**Kod** | Page<br>**Sida** |
|---|---|---|---|
| Research Administration | RA | **52** | **2** |



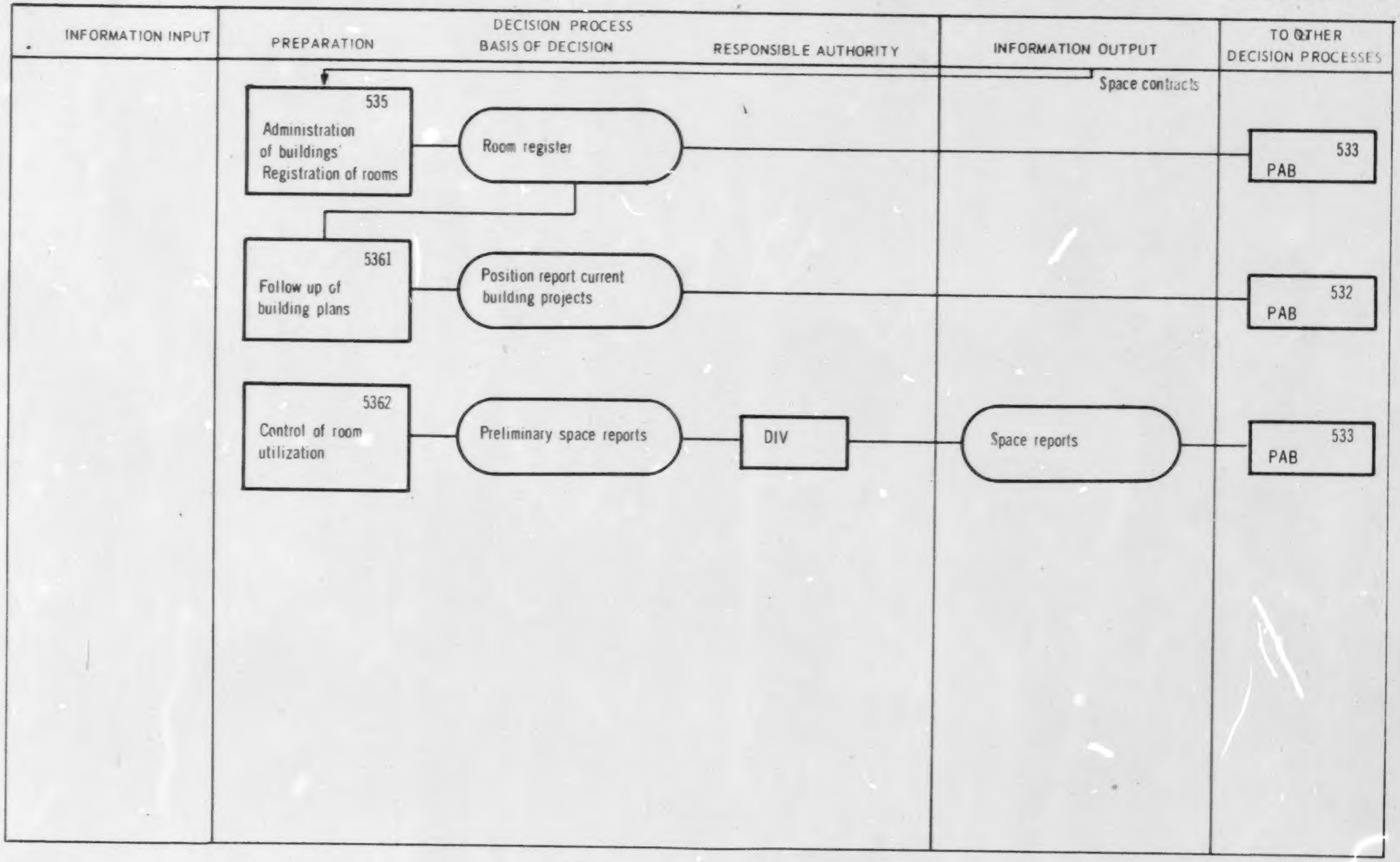
INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
Grants to CTH-projects
5241 Planning of CTH-projects
Preliminary project plans CTH-projects
PROJL
Projects plans CTH-projects
345 TR/X
5251 RA
522 Project catalogue
5242 Working out PR-programme for CTH
Programme of contacts and information
CCR
Programme of contacts and information
5241 Project plans CTH-project
Proposed commission
5251 Administration of projects and commissions
Proposed contracts
DIV
CC
Commission contracts
523 TR/X
5251 Contacts and information arrangements
3X6 Position reports
522 Project catalogue
526 Collection and follow up of position reports Control of effectiveness
Proposed measures
Effectiveness TR
521 RA
521 RA
RC

| Hierarchical Model of Decision (page 16) | | Code | Page |
|---|---|---|---|
| Field of Decision | Abbr. | **Kod** | **Sida** |
| Planning and Administration of Building | PAB | **53** | **1** |


INFORMATION INPUT
PREPARATION
DECISION PROCESS
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
G Max-grants for buildings
511 Space requirements, UTE
521 Space requirements, TR
5361 Position report current project
KBS Detailed building plans
OCU Rules for allotment of space
513 Lecture schedule
513 Examination schedule
533 Space reports
535 Room register
531 Long-term space planning
532 Registration of current building projects. Allotment of space
533 Planning for disposition of joint rooms
534 Decisions concerning rentals and hiring of space
Building plans
Proposed space allotment
Preliminary schedule
Space capacity plan
Rental-, hiring contracts
LUP
LUP
CA
CA
Building programme
Building disposition plan
Room schedule
Space capacity plan
Space contracts
KBS
Ec 411
Users
Users
Ec 415

Hierarchical Model of Decision (page 17)

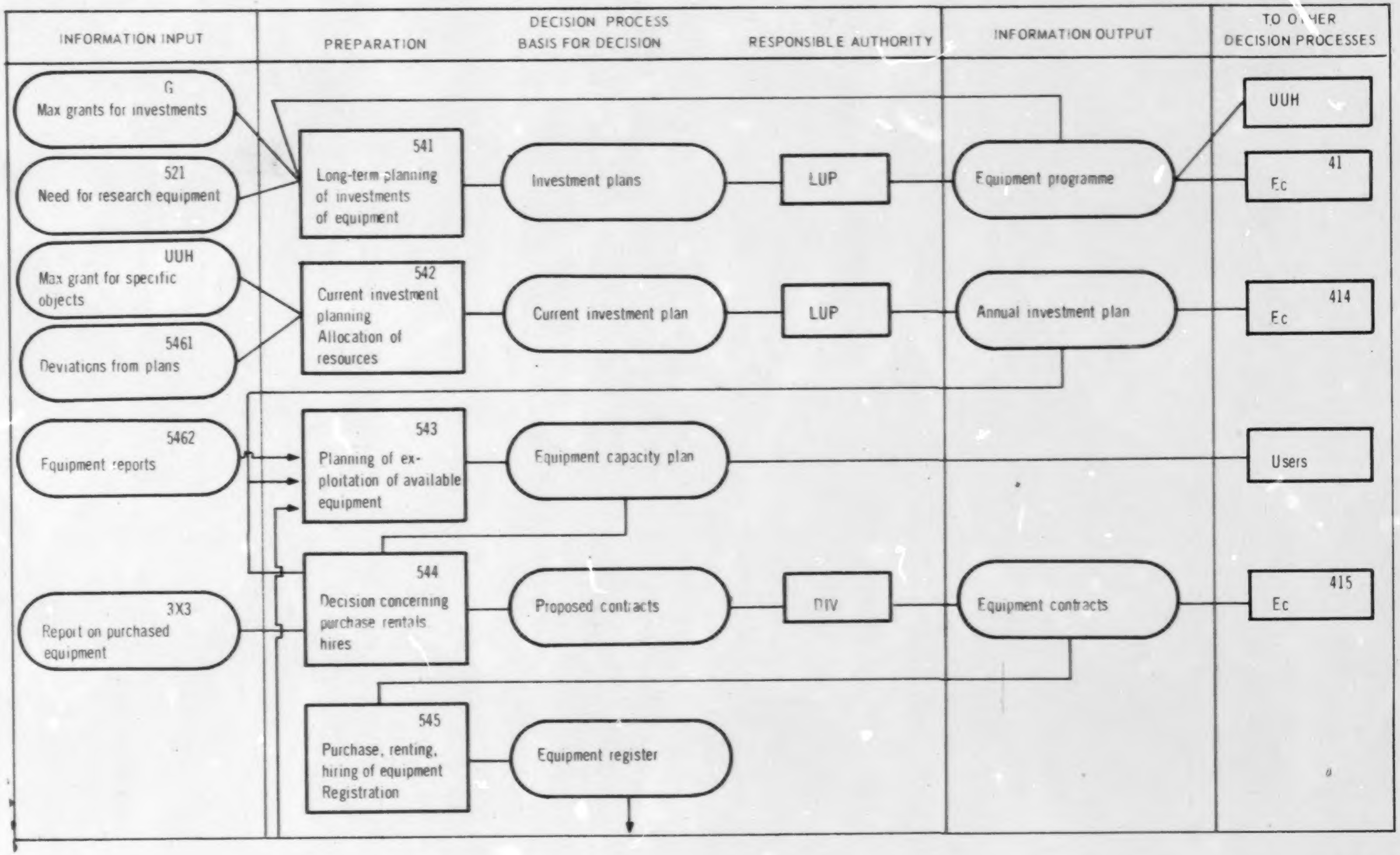
|  |  | Code | Page |
|---|---|---|---|
| Field of Decision | Abbr. | **Kod** | **Sida** |
| Planning Administration of Buildings | PAB | **53** | **2** |



INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS OF DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
Space contracts
535
Administration of buildings' Registration of rooms
Room register
533
PAB
5361
Follow up of building plans
Position report current building projects
532
PAB
5362
Control of room utilization
Preliminary space reports
DIV
Space reports
533
PAB

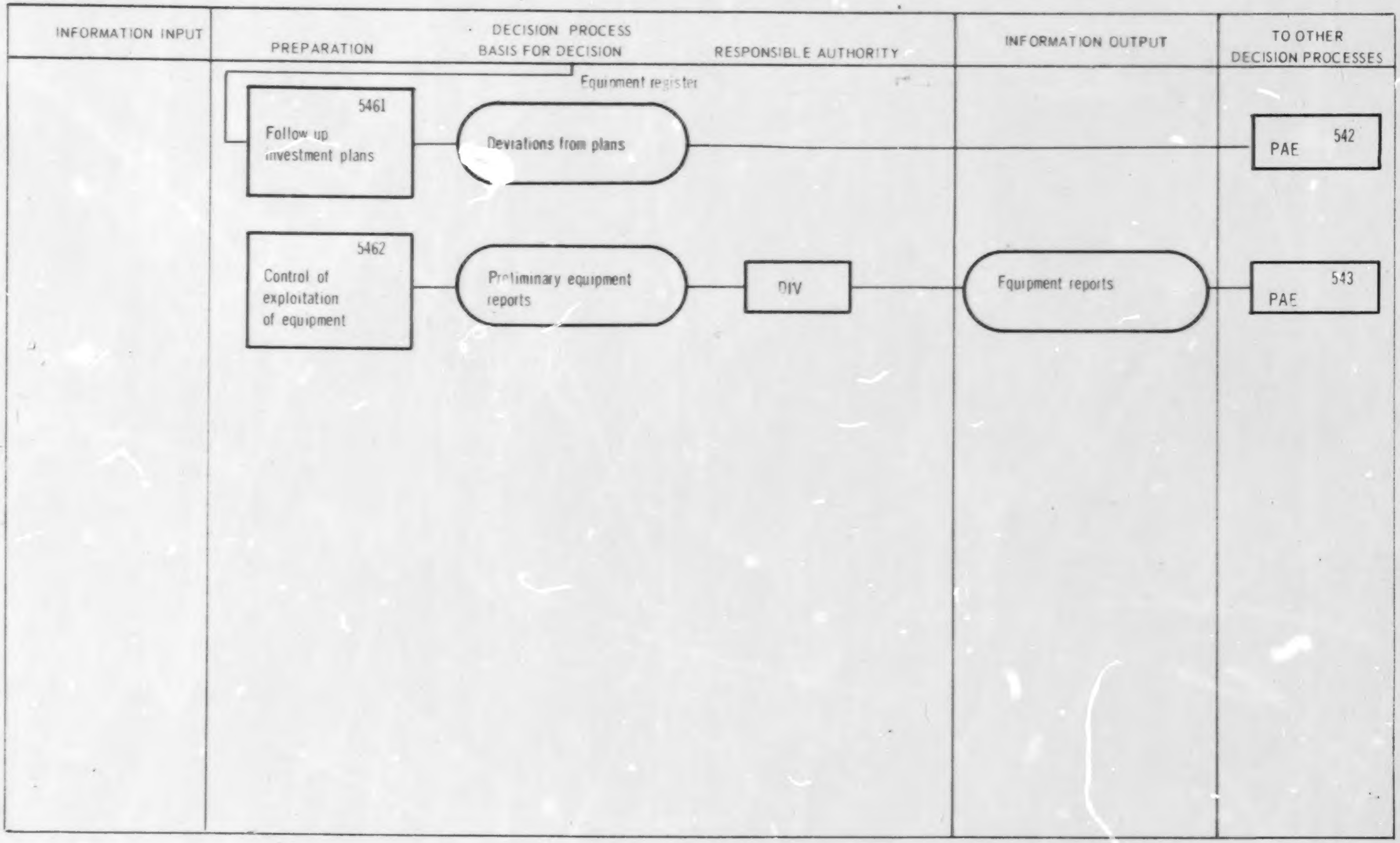
Hierarchical Model of Decision (page 18)

| Field of Decision | Abbr. | Code<br>Kod | Page<br>Sida |
|---|---|---|---|
| Planning and Administration of Equipment | PAE | **54** | **1** |


INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
G
Max grants for investments
521
Need for research equipment
UUH
Max grant for specific objects
5461
Deviations from plans
5462
Equipment reports
3X3
Report on purchased equipment
541
Long-term planning of investments of equipment
542
Current investment planning Allocation of resources
543
Planning of exploitation of available equipment
544
Decision concerning purchase rentals hires
545
Purchase, renting, hiring of equipment Registration
Investment plans
Current investment plan
Equipment capacity plan
Proposed contracts
Equipment register
LUP
LUP
DIV
Equipment programme
Annual investment plan
Equipment contracts
UUH
41
Ec
414
Ec
Users
415
Ec

Hierarchical Model of Decision (page 19)

|  |  | Code | Page |
|---|---|---|---|
| Field of Decision | Abbr. | **Kod** | **Sida** |
| Planning and Administration of Equipment | PAE | **54** | **2** |


INFORMATION INPUT
DECISION PROCESS
PREPARATION
BASIS FOR DECISION
RESPONSIBLE AUTHORITY
INFORMATION OUTPUT
TO OTHER DECISION PROCESSES
Equipment register
5461
Follow up investment plans
Deviations from plans
PAE 542
5462
Control of exploitation of equipment
Preliminary equipment reports
DIV
Equipment reports
PAE 543

## Appendix IV A

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## Appendix IV B

## INDEX OF ABBREVIATIONS AND SPECIAL NOTATIONS

ABBREVIATION/NOTATION

A (=Department (School) of Architecture)
Academies
ARC (= Swedish Atomic Research Council)
Assistant Lecturer
Associate Professor

Board of the Computer Centres
Board of University
BRC (= National Council for Building Research)
BTD (= Board for Technical Development )
Budget Request

C (= Department (School) of Civil Engineering)
Central Committee of Education
Ch (= Department (School) of Chemical Engineering)
Commission
Committees of Education, CTH
Committees of Education, OCU
Compensation
Complementery Costs
Computer Centre
CTH (= Chalmers University of Technology)

DAE (= Division of Applied Electronics)
Dean
Departments, CTH
Development Company
Direct Costs
Divisions, CTH
DSM (= Division of Soil Mechanics Engineering)
DTP (= Division of Theoretical Physics and Mechanics)

E (= Department (School) of Electrical Engineering)
Effectiveness
Efficiency
Equipment costs
External Goals

Faculties
Fields of Decision
Foundations
FTEGS (= Full-Time Equivalent Graduate Student)

Goal-chain
Goal fulfilment
Government
GT (= Graduate Training)
GU (= University of Gothenburg)

Higher Education (= Undergraduate Technical Education and Graduate Training)

Indirect Costs
Internal Goals (Objectives)
IVA (= Royal Academy of Engineering)

KBS (= National Board of Building and Planning)

Lecturer (= University Lecturer)
LUP-Committee (= Local Planning Committee of Building and Equipment for the Swedish Universities)

M (= Department (School) of Mechanical and Naval Engineering)
Main Programmes (= Undergraduate Technical Education, Graduate Training Technical Research)
Ministries

NRC (= Swedish Natural Science Research Council)

OCU (= Office of the Chancellor of the Swedish Universities)
Offices for teachers and scientists

Parliament
Ph. (= Department (School) of Engineering Physics)
Ph. math. (= Department of Engineering Physics, Section for Mathematics)
Ph. phys. (= Department of Engineering Physics, Section for Physics)
Primary Information
Productivity
Professor
Programme
Programme Budget Proposal
Programme Grant

RC (= Research Councils)
Research Assistant
Reservations
RIFO (= Association of Members of Parliament and Research Workers)
Royal Academy of Agriculture and Forestry

Royal Academy of Engineering (IVA)
Royal Academy of Science

Schools, CTH
Science Advisory Council
Secondary information
Scientist
SEA-system (= State Economic Administrative System)
SFR (= Student Faculty Ratio)
Space costs
Supervisor

Time Utilization Survey
Total Costs
TR (= Technical Research)

UEE (= Undergraduate Engineering Education = UTE)
Ultimate Goals
University Lecturer (= Lecturer)
UTE (= Undergraduate Technical Education)
UUH (= Equipment Board for the Swedish Universities)

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